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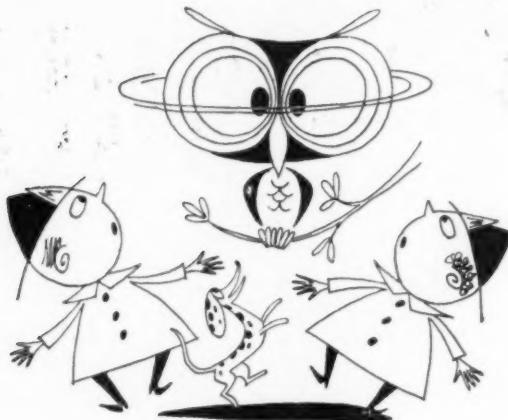
# Journal

AMERICAN  
WATER WORKS  
ASSOCIATION

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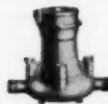
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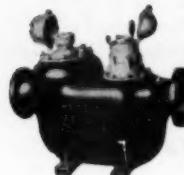
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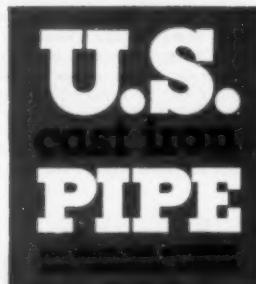


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Second, the water in the reservoir had a very disagreeable fishy taste and odor with a threshold odor value of 200 plus. Tests proved that algae did not cause the fishy taste and odor which probably was caused by a "turn-over" of the water in the reservoir due to a temperature change. When the fishy type taste and odor is present in this raw water supply, the threshold odor must be reduced to 6 to provide a palatable water supply.

**SOLUTION:** Laboratory tests indicated that 90 ppm Aqua Nuchar A would be

required to reduce the raw water threshold odor value of 200 to the palatable level of 6. With the application of Nuchar in the plant, only 60 ppm was required to reduce the disagreeable fishy type taste and odor in the water. Considerably less Nuchar was required to eliminate the 5 ppb phenol in the reservoir water as a taste source.

The Aqua Nuchar was first fed to the water as it passed around the baffle of the settling basin. As relatively high dosages of Nuchar A would be required to produce an acceptable water, it was decided to move the point of application to the mixing basin. This point of application provided the following advantages: 1. Increased the contact time by approximately two hours. 2. Provided better mixing of the carbon with the water. 3. The carry-over of carbon on the filters was minimized, thus avoiding filter difficulties. 4. Stabilization of sludge since the greater part of the Nuchar would settle in the settling basin. 5. Moved the feeding facilities within doors to insure more prompt attention even in inclement weather.

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## Journal

## AMERICAN WATER WORKS ASSOCIATION

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September 1952

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# Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 44 • SEPTEMBER 1952 • NO. 9

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## The Kansas Flood of 1951

By N. T. Veatch

*A paper presented on May 6, 1952, at the Annual Conference, Kansas City, Mo., by N. T. Veatch, Partner, Black & Veatch, Consulting Engrs., Kansas City, Mo.*

MUCH has been said and published concerning the great flood in the Kansas River Basin in July 1951. Measured in terms of human suffering, tremendous losses in property, and extensive disruption of business activities throughout the flooded area, it was the greatest catastrophe within the history of the region. Measured in terms of river stages and discharges, and of extent of the areas inundated, it was the greatest flood in the Kansas River Basin of which there is reliable record. Such sketchy records as are available indicate that perhaps the great inundation, which occurred in 1844, produced higher stages in the lower valley, but information on this flood is based almost wholly upon legend. Another great flood occurred in the basin in 1903, and inasmuch as it produced the greatest discharge and highest stages on record before the July 1951 flood, it has been considered the "design flood" for protection works constructed

along the main stem and the principal tributaries of the river.

During the great flood of 1951, the valley was inundated along the main stem for a distance of almost 300 miles. All railway's entering Kansas City were out of operation—some for as long as 15 days. Not a single major east-west highway crossing the state of Kansas was open to traffic. In the Kansas River Basin, approximately 10,000 farms comprising an area of almost 900,000 acres were inundated. A large part of the farm areas flooded—approximately 94 per cent—was crop area. In the towns and cities in the basin, 22,370 residences were flooded, and of these 2,480 were destroyed. Business establishments suffered heavy losses; 3,265 were inundated and 336 destroyed. Figure 1 is an aerial view of Manhattan, Kan., during the flood. In view of the rapid progress of the inundation of the valley floor, it seems remarkable that the loss of life was only 25 persons.

### Cause of the Flood

The flood of July 1951 was the result of a prolonged period of greater than normal precipitation over the Kansas River Basin and contiguous areas. For the month of April precipitation was, in general, near or somewhat below normal for the area. In May it exceeded the normal at nearly all stations, reaching nearly twice the normal over that portion of the valley from Salina to Wamego. In June, practically all of the Kansas drainage

including Bonner Springs, Lawrence, Lecompton, and Wamego on the main stem, in the vicinity of McFarland in Wabaunsee County, and in central Pottawatomie County. Beginning on July 9 and continuing through July 12, the prolonged period of greater than normal rainfall reached its peak in a series of well-defined, intense storms, which ended in most areas by noon July 12. During this four-day period, total precipitation exceeded 6 in. in 24 per cent of the area of the basin, and 16 in. in



Fig. 1. Flood View of Manhattan, Kan.

The city water works is shown at the lower right center and the Union Pacific Railroad and the abandoned channel of the Big Blue River are shown at the lower right.

basin within the state of Kansas received more than 8 in. of rain, with up to 16 in. in the central and eastern portions of the state. Nearly all streams were in flood several times during this month, and at particularly high stages during the period June 22 to 30.

In the early days of July, all streams were receding and by July 9, were well within their banks. Rainfall during this period was, in general, at or below normal although rather heavy precipitation occurred at scattered stations

two small areas centered at Alma (17.50 in.) and at Woodbine (17.25 in.). The distribution of total rainfall for this period over the whole drainage area is shown in Table 1.

The map of the Kansas River Basin, Fig. 2, shows the principal stream courses, the existing and proposed system of flood control reservoirs, and, by isohyets, the distribution of rainfall during the storm of July 9 to 13.

This torrential rainfall, falling on the drainage area, already sodden from the prolonged period of excessive precipi-

tation in May and June, resulted in high runoff to the streams. Furthermore, the heavy precipitation occurring during the last day of the storm was concentrated in the lower part of the valley, causing almost simultaneous cresting on the main stem from Enterprise to Topeka.

### Magnitude of the Flood

Figure 3 shows the stage hydrographs for the principal gaging stations on the Kansas River for the period July 8 to 20 inclusive. As an almost immediate result of the torrential down-

TABLE 1  
*Distribution of Rainfall July 9-13, 1951*

Total Rainfall in.	Drainage Area sq mi
Less than 2	20,700
2 to 4	14,350
4 to 6	10,700
6 to 8	6,800
8 to 10	4,250
10 to 12	1,750
12 to 14	830
14 to 16	630
More than 16	50
Total Basin Area	
	60,060

13th, and at the 23rd Street Viaduct in Kansas City at 4:30 A.M. on the 14th. These crests were higher than the 1903 crests by 2.03 ft at Ogden, 1.26 ft at Wamego, 3.64 ft at Topeka, and 3.58 ft at Bonner Springs.

Figure 4 shows the discharge hydrographs for the gaging stations at Ogden, Wamego, Topeka, and Bonner Springs for the period July 8-20 inclusive. The volume of water passing the gaging stations on the main stem at the crest stages was far greater than the greatest previously known, as indicated in Table 2. For comparison,

TABLE 2  
*Discharge Rates at Crest of Flood*

Gaging Station	1951 Discharge cfs	1903 Discharge cfs	1951 Total Flood Discharge acre-ft
Ogden	298,000	162,000*	3,453,000
Wamego	399,000	257,000*	4,678,000
Topeka	469,000	253,000	5,120,000
Lecompton	483,000	266,000	5,295,000
Bonner Springs	510,000	242,000*	5,831,000
Kansas City	512,000	260,000*	—

\* Estimated.

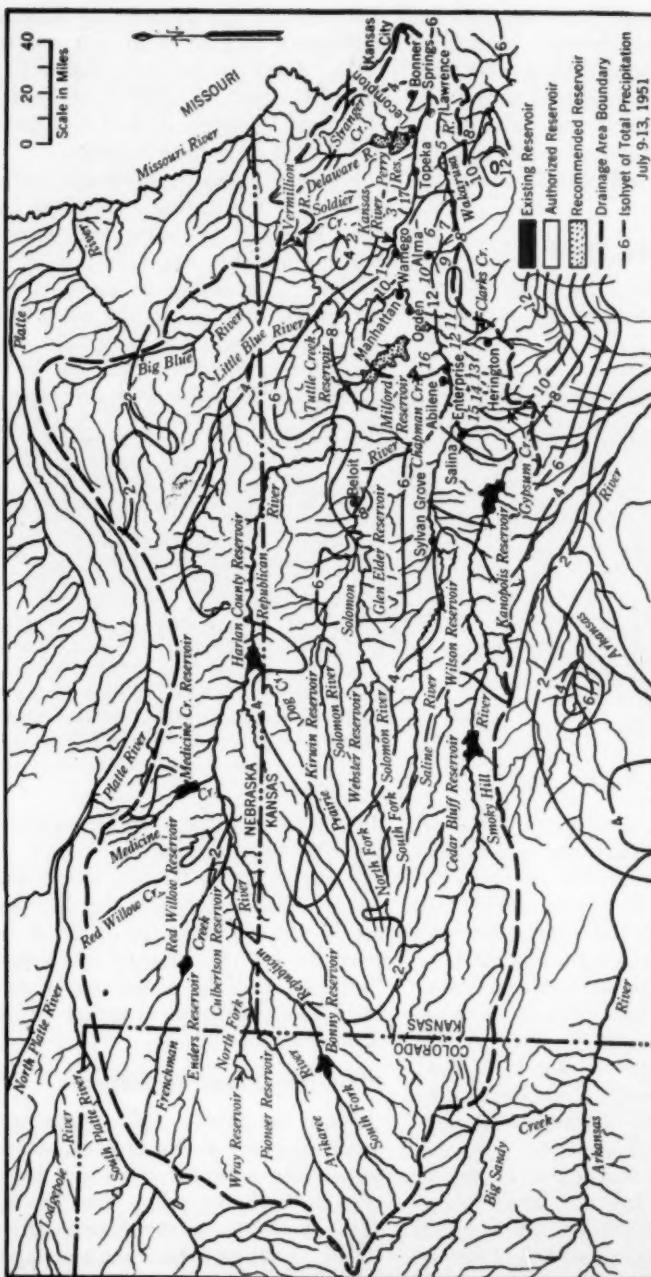
the discharge rates at crest heights for the 1903 flood are given.

Figure 3 shows that the stages were within 1 ft of the crest level at Wamego for 36 hr, at Topeka for 37 hr, at Lecompton for 35 hr, and at Bonner Springs for 27 hr, a fact which indicates prolonged submergence of the flooded areas.

### Plans for Flood Protection

Since the flood of 1903, much study has been given to the problem of protecting the principal cities and industries in the lower valley from the ravages of floods in the Kansas River Basin. Various federal and state agen-

pour that began on July 9, the level of the principal streams, which had been falling during the period from July 6 to 9, began to rise and by late evening July 10, the main stem was rising rapidly at all stations and by midnight had reached overbank stages at all stations from Lecompton west. Stages reached at the crest of the 1903 flood were reached in the 1951 flood at Ogden, Wamego, and Topeka by 9:00 A.M. of July 12 and at Bonner Springs by 5:00 A.M. of July 13. Crest stage was reached at Ogden at 10:00 P.M. on July 12, at Wamego and Topeka at 6:00 A.M. on July 13, at Bonner Springs at midnight on the



**Fig. 2. The Kansas River Basin**  
*Isohyetal lines delineate areas of equal rainfall. The numbers refer to the following proposed reservoirs: 1—Camp Creek; 2—Omaha; 3—Rossville; 4—Linwood; 5—Clinton; 6—Kinsley; 7—Nehring; 8—Halifax; 9—Illinois; 10—Spring Creek; 11—Humboldt; 12—Woodbine; 13—Turkey; 14—Holland; 15—Gypsum; 16—Suthen Mill; and 17—Grove.*

cies and private groups have been studying the problem and many plans have been proposed. Considerable sums of money have been spent in constructing flood control reservoirs, levees, and flood walls. In spite of all of this activity, however, the net result, at the beginning of the 1951 flood, was that the flood control works

ently did carry that quantity safely. It was not intended to protect against extreme floods except as such flood flows are snubbed by the operation of an extensive system of flood control reservoirs on the major tributaries. These major tributaries discharge into the main stem at and above Manhattan, 142 miles from the mouth of the river.

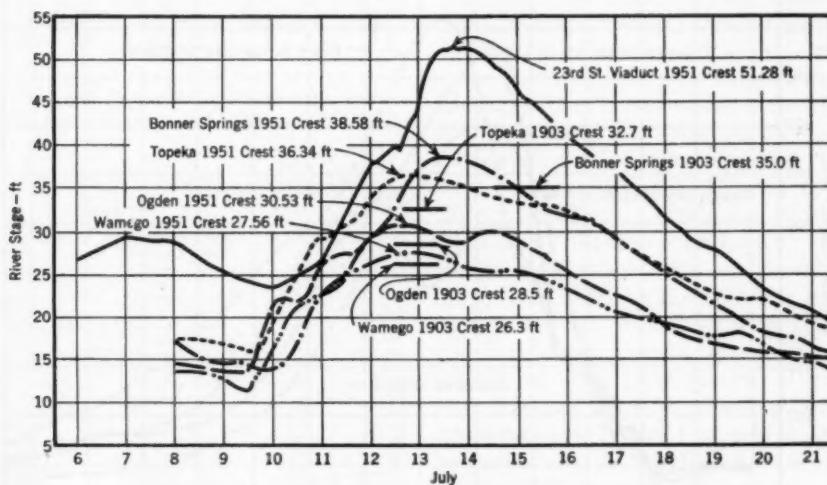


Fig. 3. Stage Hydrographs for the 1951 and 1903 Floods

The 23rd St. Viaduct is located 2.1 miles above the mouth of the Kansas River, Bonner Springs 20.2 miles, Topeka 82.3 miles, Ogden 158.9 miles, and Wamego 123 miles. Flood stage at Topeka and Bonner Springs was reached at 21 ft, at Ogden 18 ft, and at Wamego 16 ft.

existing at that time in the lower valley were totally inadequate to prevent inundation of the highly important agricultural, industrial, and residential areas along the river's course.

The levee and flood wall system extending along both banks of the Kaw River through the Argentine, Armourdale, and Central Industrial districts of Kansas City, which was overtopped at all points by the 1951 flood, was designed to protect against a maximum flood flow of 260,000 cfs and appar-

At the time of the 1951 flood, only five of the flood control reservoirs had been constructed and were in operation, including the Kanopolis and Cedar Bluff Reservoirs on the Smoky Hill River, and the Bonny, Medicine Creek, and Enders Reservoirs on the upper reaches of the Republican River. The Kanopolis Reservoir is 368 river miles from the mouth of the Kansas River; its operation had little effect upon flood stages at Kansas City. The three reservoirs on the Republican

River system—Enders and Medicine Creek in western Nebraska and Bonny in Colorado—are in areas which received relatively light rainfall during the July 9 to 13 storm, and probably had no effect on river stages at Kansas City. The Harlan County Reservoir, located on the Republican River near

Congress include Milford on the Republican River near Junction City, and Perry on the Delaware River near its mouth. These reservoirs, all located on major tributaries, will materially affect high flood stages at Kansas City, provided they have adequate flood storage capacities.

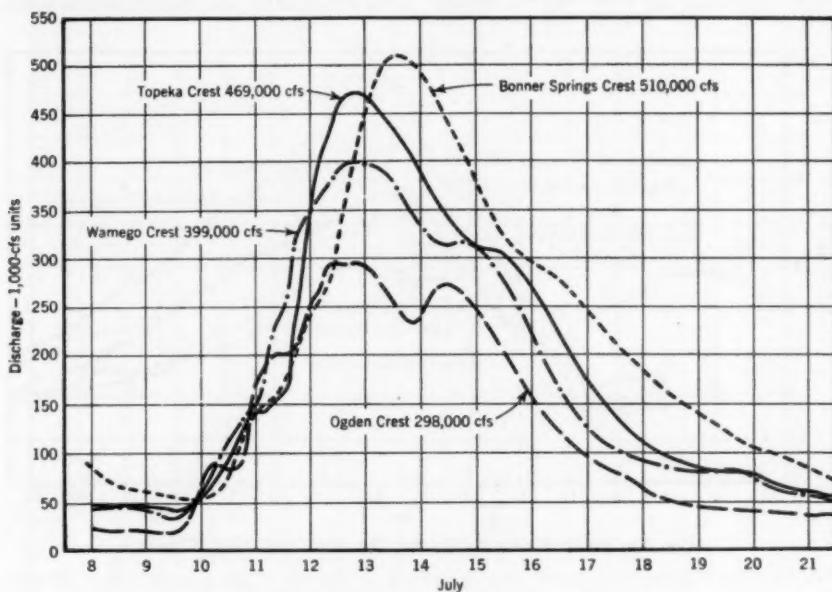


Fig. 4. Discharge Hydrographs for 1951 Flood

*Flood stage was reached at Bonner Springs at a discharge rate of 110,000 cfs, at Topeka 68,000 cfs, at Wamego 52,000 cfs, and at Ogden 40,000 cfs.*

Alma, Neb., has been completed and placed in operation since the July 1951 flood.

Additional reservoirs, authorized by Congress but for which no appropriations have been made, include the Tuttle Creek Reservoir on the Big Blue River near Manhattan, Glen Elder on the Solomon River near Beloit, and Wilson on the Saline River near the town of Sylvan Grove. Others recommended but not yet authorized by

It may be stated, however, that if all authorized or definitely planned flood control reservoirs, including the Tuttle Creek, Milford, and Perry Reservoirs, had been operating during the July 1951 flood period, the reduction in maximum stage at Kansas City would not have been sufficient to prevent overtopping of the levees and flood walls in the Argentine, Armourdale, and Central Industrial district areas.

An intensive study of the ravages of the 1951 flood and of the data provided by this flood, has made necessary not only the reexamination of the adequacy of the presently authorized flood control program, but also a study of possible further expansion of the program to include potential reservoirs on minor tributaries entering the main stem downstream from most of the major tributaries. After

TABLE 3  
*Proposed Reservoirs on Minor Tributaries*

Reservoir*	Stream	Drainage Area above Dam sq mi	Estimated Required Storage acre-ft
Gypsum	Gypsum Creek	172	110,000
Holland	Holland Creek	82	52,500
Turkey	Turkey Creek	150	96,000
Woodbine	Lyons Creek	160	105,000
Surphee Mill	Chapman Creek	285	152,000
Humboldt	Clark's Creek	205	134,000
Spring Creek†	Spring Creek	25	17,000
Illinois†	Illinois Creek	27	17,700
South Branch†	Middle Branch	37	23,300
Halifax†	East Branch	22	11,400
Nehring†	Nehring Creek	18	12,500
Kinsley†	Kinsley Creek	20	12,500
Camp Creek	Rock Creek	139	52,000
Onaga	Vermillion Creek	241	77,500
Rosaville	Cross Creek	152	48,700
Grove	Soldier Creek	255	81,600
Linwood	Stranger Creek	477	137,000
Clinton	Wakarusa River	264	83,000
	Totals	2,731	1,223,700

\* Flood storage allocations for Onaga, Linwood, and Clinton reservoirs were taken from "Kansas River Flood Report" (1). For all other reservoirs, estimates of required storage are based upon calculated runoff from storm of July 9 to 13, 1951, assuming no discharge during storm runoff period.

† Tributaries of Mill Creek in vicinity of Alma, Kan.

such a study, the Corps of Engineers has developed a supplementary plan which was presented to the Missouri Basin Inter-Agency Committee on Dec. 14, 1951. This plan is based upon the 1951 flood, and includes a number of proposed additional reservoirs and local levee projects. It suggests, also, the elimination of the multiple-purpose feature in the operation of the authorized Tuttle Creek Reservoir and the recommended Milford and Perry Res-

ervoirs in order to provide increased flood storage capacity and "dry dam" operation. Additional reservoirs proposed under this plan are listed in Table 3.

### Drainage

Of the total area of the basin—60,060 sq miles—the runoff during the July 1951 flood from 11,813 sq miles reached main drainage channels above the control reservoirs in existence at that time—the Kanopolis, Bonny, Enders, and Medicine Creek Reservoirs. As the Harlan County Reservoir on the Republican River has been completed, the area above control reservoirs is now 28,613 sq miles. Completion of the additional reservoirs authorized by Congress—Tuttle Creek on the Big Blue, Glen Elder on the Solomon, and Wilson on the Saline—will increase the area above control reservoirs to 45,160 sq miles. Completion of the two additional reservoirs that have been recommended by the Corps of Engineers but not yet authorized by Congress—Milford on the Republican and Perry on the Delaware—will further increase the area above control reservoirs to 50,338 sq miles. Completion of the eighteen reservoirs on minor tributaries, generally in the lower part of the basin, that are included in the supplementary plan but not in any "recommended" list will further increase the area above control reservoirs to 53,069 sq miles, or approximately 88.4 per cent of the total basin area. The area remaining uncontrolled upon completion of the overall program as outlined above, 6,991 sq miles, includes, in general, the valley floor along the main stem from Kansas City to the Kanopolis Reservoir, where, owing to unfavorable conditions, the establish-

ment of impounding reservoirs is not feasible.

### Flood Storage Allocations

Available data indicate flood storage allocations in the existing, authorized, and recommended reservoirs as shown in Table 4. Adding the total of flood storage allocations for the reservoirs on the major tributaries and the total of estimated required storage capacity for the reservoirs on the minor tributaries, the total for the overall reservoir program is 6,368,200 acre-ft. Inasmuch as the total flood discharge of the Kansas River at the Bonner Springs gaging station for the 1951 flood was 5,831,000 acre-ft, it might appear that the flood storage capacity provided by the overall reservoir program would have been sufficient to contain the entire flood flow from the basin.

Whether such protection would ever actually result depends upon several factors, one of which is the distribution of the rainfall over the drainage area. If all of the rain fell only on the drainage areas above the flood control reservoirs, there would be no surface runoff from the drainage areas below them, and the flow in the main stem would be only that released from the reservoirs. A study of the rainfall pattern for the great storms of record indicates that the heaviest rainfall usually centers in the general area of the valley below Salina, and a large portion of the runoff from such storms reaches the main stem below the proposed system of reservoirs.

Another factor relates to the operation of the reservoirs during an extended series of heavy rainstorms. To be fully effective in controlling flood flows, the total area allocated to flood control storage in each reservoir

should be empty at the beginning of a great flood-producing storm. During periods of high runoff, the rates of discharge through the outlet works must be so regulated that the outflow, in addition to the runoff from local drainage areas below the dam, will not exceed the channel capacity, yet will be great enough to drain the floodwater from the reservoir as quickly as

TABLE 4  
*Flood Storage Allocations\**

Reservoir	Flood Storage Allocation acre-ft
<i>Existing</i>	
Kanopolis	400,000
Cedar Bluff	180,000
Harlan County	500,000
Medicine Creek	53,000
Enders	30,000
Bonny	132,000
Total Existing	1,295,000
<i>Authorized</i>	
Tuttle Creek	2,095,000†
Glen Elder	183,000
Wilson	145,000
Kirwin	105,000
Webster	94,000
Culbertson	95,000
Red Willow	22,000
Norton	—
Wray	3,500
Pioneer	73,000
Total Authorized	2,815,500
<i>Recommended</i>	
Milford	700,000
Perry	334,000†
Total Recommended	1,034,000
Total Flood Storage Allocations	5,144,500

\* Flood storage allocations were taken from House Document No. 642 (2).

† Flood storage capacity obtained by eliminating conservation pool allocations.

possible, so that it may be fully available for the next flood. If a period of heavy runoff, during which a considerable volume of floodwater is stored, is followed by a second period of heavy runoff, it may be practically impossible to drain off the stored water before the runoff from the second storm reaches the reservoir.

A situation of this kind occurred at the Kanopolis Reservoir in the flood period of 1951 when, from May 15 to July 1, there were seven periods of relatively high rates of inflow. The criterion governing the regulation of outlet rates was the stage in the river at Salina, approximately 80 miles below the reservoir. The result of controlling the outflow to meet this criterion was a continued rise in the water level in the reservoir. On July 1, the stage was 3.90 ft below spillway crest, at which stage 82 per cent of the storage volume allocated to flood water storage was occupied. In early July, with decreasing inflow rates and falling stages in the river below Salina, outflow rates were greatly increased, and on July 10 the water level in the reservoir had fallen to 6.45 ft below spillway crest. At this level, 74.6 per cent of the flood storage volume was occupied. The storm of July 9 to 13, although relatively light on the drainage area above the reservoir, produced inflow rates greater than those of preceding rises during May and June, and at noon on July 14, the water level in the reservoir stood at 0.10 ft below spillway crest. Fortunately, the spillway was not overtopped, but the margin was very, very slender.

Had the operation of this reservoir been governed only by the requirement that the water level be held as closely as possible to the conservation pool level—48 ft below spillway crest, in effect, the "dry reservoir" method of operation—the water level on July 10 would have been approximately 34 ft below spillway crest with the flood storage volume 16 per cent occupied. No method of operation could have been devised for this reservoir which would have resulted in the flood storage area being empty on July 10.

### Flood Similarities

Comparing the great storm of July 9 to 13, 1951, with the greatest previous storm on which there are conclusive records—that of May 26 to 31, 1903—it is found that both storms were centered in the area of Abilene, Herington, and Manhattan; both produced protracted and unusually heavy rainfall over great areas with maxima at the storm centers of 16 in. or more; and both were preceded by prolonged periods of greater than normal precipitation. The general similarity of the weather pattern producing these great storms is of interest. At both times, large masses of warm, moist air from the Gulf of Mexico were drawn into a low-pressure trough and were stalled over the Central Plains by the presence of a standing high-pressure ridge located to the west and northwest. The southward movement of cold air masses into the trough made contact with the warm air masses, and produced torrential rains over the Kansas River and contiguous drainage basins. In the 1951 storm period this weather pattern persisted, with occasional interruptions, for nearly two months. In the 1903 storm period it persisted for approximately one month. Other great storms resulting from a generally similar weather pattern have produced great floods in the Kansas River Basin during the period between 1903 and 1951.

### Combination of Methods

In addition to the plans proposed for flood control in the basin by means of impounding reservoirs, supplemented by levees and flood walls for the protection of local areas, many other ideas and proposals have been advanced. The Soil Conservation Service seeks to prevent major floods by watershed

treatment, a method which would retard runoff practically at its source as well as prevent erosion of the soil. Others favor the construction of high levees and flood walls to prevent the inundation of critical areas in the towns and cities in the lower valley. Still others favor providing broad floodways by setting back levees and removing all structures within the floodway boundaries.

It is the author's opinion that all of these proposals possess merit and should be considered in any overall study of the problem of flood prevention in the Kansas River Basin. In view of the experience of the great flood of last summer and a study of the data pertaining thereto, it can by no means be stated with assurance that any one method, be it impounding reservoirs, watershed treatment, levees and flood walls, or floodways, can wholly prevent flooding in the lower valley. To attain the desired results will require the use of all these methods.

It does seem clear that the characteristics of stream flow in the Kansas River system, both as to variation in quantity and silt load, make the development of the "dry dam" type of flood control reservoirs the most prudent and economical method.

The author is not prepared to state that the 1951 flood will not be exceeded by still greater floods. A study now being made in the author's office indicates that had the July 9 to 13 storm been centered a few miles to the north of its actual location—a situation by no means impossible—under the same conditions, the resulting flood flow at Kansas City would have been almost 700,000 cfs, or almost 35 percent greater than the peak flow of the 1951 flood. There seems to be no reason, from a meteorological point of view, why such a situation could not occur.

#### **Acknowledgment**

Data used in the preparation of this paper have been taken from publications of the U.S. Geological Survey, the U.S. Weather Bureau, and the Corps of Engineers.

#### **References**

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2. Kansas River and Tributaries, Colorado, Nebraska, and Kansas. House Document No. 642. U.S. House of Representatives, 81st Congress, Second Session (1950).

# The Complexities of a National Water Policy

By Abel Wolman

*An address presented on June 4, 1952, at the Twentieth Annual Convention of the Edison Electric Institute, Cleveland, Ohio, by Abel Wolman, Prof. of San. Eng., Johns Hopkins University, Baltimore, Md. Reprinted by permission of the Edison Electric Institute.*

THE expenditures for water resources development in the United States are approaching several billion dollars annually. Federal projects contemplated for the next ten years will undoubtedly exceed 50 billion dollars. These developments cover the entire field of domestic and industrial water supply and pollution, flood control and water flow retardation, navigation and inland-water transportation, irrigation, hydroelectric power, recreation, fish and wildlife, land drainage, and the collection of basic water resources data.

It may surprise some people to know that less than a quarter of a century ago the problems of water development appeared relatively simple and certainly less confusing than today. One important explanation for this change in both the number and the complexity of issues is that, until about 1930, water projects were dominantly local or regional in character, were fewer in number, and were largely single purpose in function. With the exception of the Colorado River development and the flood protection program in the lower Mississippi Valley, federal interest in such undertakings was largely restricted to developments under the general Reclamation Act of 1902.

## Unprecedented Federal Participation

The excessive drought of the 1930 to 1932 period, the great economic de-

pression, the extraordinary rainfall periods of 1936 to 1938, inclusive, accompanied by a social philosophy based on relatively broad federal obligations, changed the entire picture by 1940. These events pushed federal participation with legislative sanction into a variety of fields of water development to a degree unprecedented in previous history. These steps, accompanied for the most part by the virtual elimination of local financial participation, resulted, first, in a tremendous expansion of annual expenditure and, secondly, created great legislative confusion in national policy with respect to specific agency responsibility and to practices of local reimbursement.

Such a difficult impasse was apparent as early as 1935. Until the early 1940's the National Water Resources Committee struggled with many of these problems. This committee made many recommendations directed toward the integration and simplification of legislative policy, administrative responsibility, and local financial participation. Its recommendations, as many of those which have followed, are distinguished primarily by their almost complete failure to capture either citizen interest or legislative and executive acceptance.

## Engineers Joint Council

Once the checkrein of local financial participation was eliminated in

such projects as flood control and reduced in others, competitive confusion and annual federal expenditures increased ten-, twenty-, and fifty-fold. This state of affairs became so acute by 1949 that the Engineers Joint Council decided that the subject be reviewed once more in order to attempt a further restatement of principles, if these could be unanimously agreed upon as a guide for legislative action and administrative practice.

The Engineers Joint Council represented the following five national engineering societies: the American Society of Civil Engineers, the American Society of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Institute of Chemical Engineers. The combined membership of these societies is approximately 130,000. Some 80 engineers participated in this study and analysis of the water resources problem of this country, and in 1950 the council presented to the President's Temporary Water Resources Policy Commission "A Statement of Desirable Policy With Respect to the Conservation, Development, and Use of the National Water Resources."

### **Findings of Panel**

Contrary to prediction, this large group of engineers, chosen from every field of experience and representing, in many instances, individuals long in public office on the federal, state, or local levels, produced proposals of practically complete agreement. Their efforts in the monetary sense would represent about a quarter million dollars of normal engineering fees, though none of these men were reimbursed for their extensive, objective deliberations. The essential findings of the Engineers Joint Council panel differ

little from those reached by most objective students of the problem over the last half century. Four significant general principles emerge, as follows:

1. Local, state, and private responsibility should be preeminent and be consciously and effectively nurtured and extended in water-project programming.

2. Bookkeeping should be clear and forthright and should be based upon full inclusion of all costs and reimbursements.

3. Costs should be collected from those benefited either directly or in a subsidiary way. General intangible benefits should preferably be regarded as a margin of advantage in project selection.

4. Legislative authorization and policies should be uniform for all the federal agencies responsible for water-resources development.

The President's Temporary Water Resources Policy Commission presented its report in January 1951, and prepared legislation to put its recommendations into effect. The proposed legislation, however, was not released to the public until the spring of 1952. That commission, too, found the same inconsistencies and incongruities under existing congressional enactments, the same competitive standards of economic justification, and the same variations in allocation of cost between those benefited and the general federal taxpayer.

### **Lack of Single, Uniform Federal Policy**

The conclusion of the President's Commission is particularly striking, since once more it points up the findings of almost every individual or group that has reviewed this problem. The commission states that "There is today no single, uniform federal policy gov-

erning comprehensive development of water and land resources. This is a time for action based on sober consideration of objectives and methods. Continuation of present policies, or lack of them, will mean a continuing waste of money and effort in the pursuit of conflicting goals."

It is not captious to point out that, in the light of these repeated striking conclusions, the impatience of political leaders to move forward rapidly with great federal expenditures is one of the most alarming characteristics of 1952. One cannot escape the conclusion that this desire to move forward with great rapidity, even though the goals and the methods of obtaining the goals may both be flagrantly in error, can only be the product of misguided emotion or of political necessity or both. The real challenge in this entire problem is how such a tide of activity may be stemmed long enough to take stock and to adjust policy and method so that expenditures of whatever amount, large or small, are made with as much technical and social wisdom as we may summon. In none of the deliberations briefly summarized to this point has the objective been primarily to agree upon one magic amount of annual expenditure versus another. All of the discussions have centered on the problem of spending what we do spend for water-resources development in the most logical, the most competent, and the most economical manner.

When these problems are discussed, however, it is often charged that the proposals are antisocial, that they will deprive people of their appropriate share of our water resources. We have reached a strange impasse when any proposal for intelligent stock taking of our policy for water-resources development is met with the charge that such proposals are contrary to

national welfare. To spend for the sake of spending can hardly be a permanently sound objective of national policy. Senator Douglas has aptly paraphrased the problem in water-resources use, as in other areas, by his comment that "one can be a liberal without being a wastrel."

Since most of the discussion up to this point has been concerned primarily with principles, it is useful to apply these principles to a specific case. For such a case history, the projected program for the Missouri Basin is chosen, not only because it represents the largest project hitherto proposed but, more important, because it illustrates in its project planning and execution some of the deficiencies with which the citizen of this country should be concerned.

#### **The Missouri Basin Program**

The Missouri Basin is more than 500,000 sq miles in area, includes all or some of ten states, and contains some 8,000,000 people. It is larger than the combined areas of France, Belgium, the Netherlands, Denmark, Germany, Switzerland, and Italy. For sheer size alone, it should give the planner considerable pause. If we were confronted with the planning of a water-resources development program for the countries just mentioned, we probably would insist upon a reasonably long period for technological analysis, for project evaluation, for execution, and for financing. In this area, however, many of these objectives have been telescoped into a period of less than ten years. Already almost a billion and a half dollars have been spent on projects, and somewhere between eight and twelve billion dollars of expenditure are contemplated for the future.

In the undertaking, competitive legislative policy and competitive agency

responsibility are still unresolved. Sharp conflicts of opinion between the Department of Agriculture, the Department of the Interior, and the Corps of Engineers still prevail, although these conflicts are masked under the general "cover-all" of the Pick-Sloan Plan. This plan has undergone major change as experience and natural calamities have pointed up difficulties therein. Battles between the advocates of upstream proposals for retardation of runoff and downstream proposals for major impoundments make interesting reading but remain poor bases for ultimate solution.

### Local Participation Planning

Owing to the fact that virtually all of the undertakings, with the exception of those proposed by the Department of Agriculture, rest upon expenditures essentially federal in character and in some extreme, such as flood control, largely nonreimbursable by the beneficiaries, it is gratifying that important steps have been taken in the basin to develop a degree of local participation in planning. These steps would be even more heartening if the states and their local subdivisions had a larger and more effective participation in the repayment of costs. In execution of projects, the federal government under existing policy is dominant. When projects are completed, principles controlling operation will create parallel issues because of the highly competitive demand on multipurpose projects by various interests.

Perhaps one of the most disconcerting features in Missouri Basin project planning stems from the fact that, as natural catastrophes have occurred, major changes in program have been rapidly, if not hastily, projected. The July 1951 floods in the Kansas River

Basin presented unusual features which should carry significant warnings against the desire for speed of action. This was the greatest flood in the Kansas River Basin on which reliable records are available, and it exceeded the "design flood" of 1903 by a very considerable percentage. Analysis of this situation disclosed the further disconcerting fact that the 1951 flood peak could be exceeded by nearly 35 per cent. In the preceding paper, N. T. Veatch concluded that "There seems to be no reason, from a meteorological point of view, why such a situation could not occur."

The experience during the 1951 flood, as described by Veatch, is enlightening with respect to problems of operation. On July 1, the Kanopolis Reservoir, designed for major flood protection, contained water at such an elevation that 82 per cent of the storage volume originally allocated to flood water was unavailable. With releases subsequent to July 1, the flood-storage was still occupied to the extent of 74.6 per cent. By July 14, the water level in the reservoir was almost at spillway crest, with virtually no room for flood runoff. The initial conservation pool level in this reservoir was supposed to be 48 ft below the spillway crest. If it had been so maintained, the flood storage space on July 10 would have been only 16 per cent occupied.

Without pursuing this situation in detail, it should be borne in mind that, following the July 1951 flood, the program for controlling such a situation in the Kansas River Basin was changed by December 1951 to the extent of proposing fourteen additional reservoirs at an additional expenditure of some \$350,000,000. How can these facts be reconciled with statements by prominent officials that, if the original project

had been completed before July 1951, damages would have been avoided?

### Need for Greater Flood Protection

The 1951 flood experience in the Kansas River Basin illustrated the necessity for a vastly greater flood protection program than had ever been contemplated. The revised program, therefore, renews the demand for answers to a variety of still unanswered questions. Is the revised program an invitation to still further encroachment on the flood plain by industrial and residential property, with consequent later increases in flood damages? Is the program to be accompanied by a rigorous flood-plain zoning restriction? Is it to be paralleled by conversion of bridge openings in order to avoid the events in the Kansas City area in 1951, when inadequate bridge ports caused tremendous flooding by backwater?

From the standpoint of public policy, however, the most important feature of the whole experience lies in the following conclusion by Veatch: "Had all authorized or definitely planned flood-control reservoirs, including the Tuttle Creek, Milford, and Perry Reservoirs, been operating during the July 1951 flood period, the reduction in maximum stage at Kansas City would not have been sufficient to prevent overtopping of the levees and flood walls in the Argentine, Armourdale, and Central Industrial district areas." It is difficult to reconcile this conclusion with the emotional pronouncements of public officials, high and low, who placed the responsibility for the damages from this catastrophe on the failure of Congress to appropriate monies in 1949 and 1950. How many of them know better?

The 1952 floods on the upper Missouri Basin may result also in further

modification of the project plan. Meteorological events must be recognized, but it is disturbing to know that such major adjustments in programming are being made in the midst of rapid execution of projects. No one at the moment is prepared to state what the ultimate cost of this vast undertaking will be. No one is prepared to state which of the many competitive methods proposed will actually be developed for operating control. The battle between upstream and downstream activities is at high peak. Should billions of dollars be spent while many of these tremendously important technical, legal, and administrative issues are still quite unresolved? Is the impatience demonstrated by our great political leaders a sound guide for action? If they cannot be made aware of the acute problems which plague us, not only in the Missouri River Basin but elsewhere, cannot the citizen at least be let in on the issues?

The record so far, for persuading either Congress or the average citizen of the problems involved and of some of the contemplated solutions, is remarkably dismal in accomplishment. Many of us feel, however, that as long as there is any hope of developing policies which would be less wasteful, more uniform in character, more skillfully and technically diagnosed, the battles should continue. This battle is wholly unrelated to philosophical concepts or to political party. Both political parties have been distinguished by their careful avoidance of corrective legislative measures. Both have been unanimous, or nearly so, in promoting ill-considered projects. Placing the blame on federal agencies is neither realistic nor accurate. They can do a good job if permitted to do so!

## Interruptions to Water Service by the Kansas Flood of 1951

**By Dwight F. Metzler, Russell L. Culp, and R. G. Kincaid**

*A panel discussion presented on May 6, 1952, at the Annual Conference, Kansas City, Mo., by Dwight F. Metzler, Chief Engr., and Russell L. Culp, Chief of Water Supply Sec., both of the Kansas State Board of Health, Lawrence, Kan., and R. G. Kincaid, Partner, Burns & McDonnell Eng. Co., Kansas City, Mo.*

### Quality and Treatment—Dwight F. Metzler and Russell L. Culp

WATER works men of eastern Kansas will long remember July 1951 when they fought the most destructive flood in history. On July 13, 37 Kansas municipal water supplies were knocked out and others were damaged or threatened by the rampaging Smoky Hill, Solomon, Saline, Blue, Kaw, Cottonwood, Marais des Cygnes, and Neosho Rivers. Previous flood crests were exceeded by 6 to 10 ft on the Marais des Cygnes and Neosho Rivers. The Neosho River at Parsons carried 439,000 cfs at the peak, 39,000 more than the Missouri River carried at the height of the 1952 flood at Omaha, Neb. Estimated tangible damage to water works properties alone was in excess of \$950,000. Total tangible damage exceeded a billion dollars.

As the floodwater rose past the high marks of previous floods, the public was warned of the threat to wells and water treatment plants. Armies of volunteers responded to save such major water works as those at Topeka and Kansas City by five days of continuous sandbagging to reinforce dikes and to stop sand boils. At the same time the plant personnel were working

at top speed to keep the plant in operation. The battle which these men won is a story as dramatic as any ever conceived by a writer of fiction.

### Cause of Failures

Water supply failures were caused by flooded wells, power failures, breakage of pipelines at river crossings, flooded pumping stations, and flooded treatment plants. Table 1 gives an analysis of 37 water supply failures.

In addition to systems completely out of operation, many systems suffered damage. These systems were successfully maintained in service, however, by the use of standby wells and pumping equipment, or by emergency arrangements that were made before normal facilities failed. Fourteen supplies serving 160,000 persons were seriously damaged. Most of the wells in five cities were damaged, and low-lift facilities were flooded in three. Major parts of the distribution systems in three cities were under flood, and motor failure, major plant damage, and feeder main washouts accounted for the remaining failures.

The importance of auxiliary power was emphasized by the number of

power failures and the extent of the damage to electrical switchgear, wiring, and motors. Vertical turbine well pumps with right angle auxiliary power take-offs were operated by tractor drive and other portable gasoline engines during power outages. Stationary gasoline-powered standby pumps and electric generators also proved their value. Failure of drain lines and sewers serving the water plants protected by dikes or levees was so common that attention has been directed to the need to consider hydrostatic pressures under conditions of

TABLE 1  
*Analysis of 37 Water Supply Failures*

Cause of Failure	No. Cities Affected*	Total Population Affected	Avg. Time Out—days†
Power failure	10	24,140	11
Low-lift pump station flooded (only)	6	10,300	1
Wells flooded	11	21,960	15
Treatment plant flooded	12	40,340	13
Distribution system damaged	6	56,060	12

\* There is some duplication in the number of cities tabulated in this column because both power failure and flooding of the plant occurred in some cities.

† "Time Out" is calculated from the date the water pressure vanished to the time the water was considered to be in satisfactory bacteriological condition. After the flood waters receded from their crest, an average of approximately 2 days was required to restore pressures. Repairs were made with remarkable swiftness, the "time out" being influenced more by the waiting period for waters to recede than by cleanup work.

surcharge in future designs for these structures. Special attention to joints between pipe sections is warranted.

As soon as it appeared that a water supply might be contaminated or that the pressure in the system might drop, the consumers were notified to boil all water used for drinking or culinary purposes. Frequently the boiling orders were distributed by handbills as electric power was off and only automobile radios were operating. Sound trucks, newspapers, and radios were used when available.

Radio appeals made personally by the water works officials proved surprisingly effective in preventing water waste and panic which might have resulted from rumors in the absence of authentic news from recognized sources. In Lawrence a few hours after a broadcast asking a 15 per cent reduction in water use in order to maintain pressure in all parts of the system, the reservoirs were full and pressures restored to normal.

### Meeting the Emergency

All emergency sanitation activities were carried out under the Governor's personal direction. The complete facilities of the Div. of Sanitation, Kansas State Board of Health, were utilized to combat the effects of the flood. These were supplemented by approximately 25 professional persons assigned to the division by the U.S. Public Health Service and the Army Corps of Engineers for reassignment to problem areas. In the field, the state and federal engineers worked in cooperation with city officials, water works personnel, local health officers, national guardsmen, and the military services.

The first major problem that occurred after the floodwater rose was the supplying of drinking water to the cities affected. All sanitation requests and relief equipment were channeled through the office of the Div. of Sanitation of the State Board of Health, where a large operations map was maintained showing the supplies which were knocked out and those which were in immediate danger. The inspection reports in the files of the division were used in determining the water works which would be affected by high water and in anticipating their probable needs for equipment and supplies.

Several portable water purifiers had been stored by the board for such an

emergency but the demand soon exhausted these facilities. These purifiers were sled-mounted pressure sand filter units which were sent to cities by truck and air transport. They were ready for immediate service upon arrival at their destination. Two truck-mounted 100-gpm water purifiers were rushed into the area by the U.S. Public Health Service, and additional units were supplied by the Corps of Engineers. Although the latter equipment was packed for overseas shipment and required extra time to assemble, the lightweight, knocked-down diatomaceous earth units were adaptable to air transport, and the Army engineers moved them into the needy areas very quickly.

The purifiers were set up by State Board of Health engineers who trained local citizens as operators as rapidly as possible in order to be free for other duties. The pressure sand filters proved to be much easier to operate than the diatomite units. Tank trucks, recruited from water haulers and farmers, were sterilized and then used to distribute purified water. As an added precaution, the chlorine residual of each load was checked before it left the loading area, and boiling was recommended.

Surprisingly, there was an ample supply of automobiles equipped with public address systems. These automobiles announced the coming of water trucks. The streets were lined with assorted containers placed there by the individual householders. In some areas it was necessary to maintain this service for only a short time; in others the purification units and the tank trucks were kept busy for more than ten days. Several communities were supplied with drinking water hauled from nearby towns until temporary purification systems were placed

in operation. Fort Scott, Garnett, Moran, and Colony obtained tank trucks on their own initiative and furnished water to their distressed neighbors in Humboldt, Iola, and Ottawa.

In a few towns in which the low-service pumping station was the only water production facility knocked out, fire engine pumpers and portable pumps maintained an uninterrupted flow of raw water to the filter plants through temporary pipe connections.

Chanute, Kan., obtained drinking water from the emergency purification units, but in addition continued to provide water for fire protection, cleaning, and sanitary purposes through a temporary pipeline and pumps from a quarry pond of clear water. The distribution system was sterilized with a 50-ppm chlorine solution before normal operations were resumed. Some of the cities succeeded in supplying their customers from elevated storage even though the treatment plant and pumping station were out of service. This was done by turning on the water for a short period each day. Boiling was recommended for such supplies.

Plants that remained in operation found the normal stocks of chemicals insufficient. In fact, several plants used a month's supply in a few days. These plants also found that the water had a very high chlorine demand and that heretofore adequate reserve chlorine feeder capacity was insufficient. Additional chlorine feeders from swimming pools and improvised drip feeders using calcium hypochlorite supplemented overloaded chlorination equipment in some locations.

#### **Communications**

A lesson in communications was learned, especially in cities having water lines on both sides of the swollen streams. As telephone lines were usu-

ally knocked out or jammed with other emergency calls, and several hours was required to travel by automobile across town, even when bridges were passable, two-way radio afforded the key to successful operation. Many long distance telephone circuits were knocked out, and delays of several hours were common on emergency calls. The radio service rendered by the State Highway Patrol and amateurs avoided serious delays in obtaining essential supplies and equipment for the stricken areas.

#### Treatment and Rehabilitation

Turbidities in the Kansas River reached a recorded maximum of 8,000 ppm. To obtain satisfactory coagulation of the highly turbid water, unusually large amounts of alum were required. At the Lawrence plant, dosages up to 120 ppm were used, or approximately seven times normal rates of application. Floating oil and gasoline from inundated refineries, bulk storage plants, and filling stations created serious fire hazards. Fire protection was afforded in some places by valving off full elevated storage tanks. Other cities filled 3,000-gal transport tank trucks with water for use with pumper fire engines and kept a crew of drivers on hand at all times.

An even more important consideration was that of maintaining a supply of water to hospitals. Kansas City, Kan., with the assistance of the water department of Kansas City, Mo., won a fight against great odds in giving uninterrupted service to the Kansas University Medical Center. Water was wasted in some places through broken mains, particularly main feeder lines, to exclude turbid water and to minimize the time and effort required to clean and disinfect the pipelines after repair.

Rehabilitating the flooded water supplies and returning the systems to operation constituted a major problem. Damage to electrical switchgear and motors was extensive. In the smaller cities, kilns, ovens, and low-voltage, high-amperage current from electric welding machines were used for drying electrical equipment. In the larger cities the needs of industry coupled with that of the municipalities placed both portable and stationary motor-drying equipment at a premium. Portable equipment was driven into the area from Atlanta, Ga., by the Public Health Service.

While electrical apparatus was being dried or replaced and mechanical equipment repaired, mud and silt were removed from settling basins, filters, clear wells, and other parts of the plants and grounds. Damage to water supply wells was much less than was expected. Cleaning and disinfecting restored the great majority to satisfactory operating condition; only a few wells had to be replaced. Well failures were caused by collapsed casings and by erosion.

The cleanup job was done principally by hand labor and hosing. Mud was scraped from the surface of rapid sand filters to allow enough water to be filtered for backwashing. The sand was disinfected with a slurry of calcium hypochlorite. The walls of treated water storage reservoirs were washed with a chlorine solution and the floors were covered by 2 or 3 in. of strongly chlorinated water. Major structural damage was found at a number of underground storage reservoirs even though they were kept full to overflowing during the high-water stages. Other clear wells shifted or floated enough to break connecting piping and to require leveling by pressure grouting through holes in the

floors of the tanks. These structures were by-passed by hastily installed temporary piping when no permanent arrangement was provided.

### **Repairing and Disinfecting Mains**

Filling of the mains with safe water was speeded by local contractors. Under the guidance of the Corps of Engineers and local officials, the contractors in the Kansas River Basin were organized into local groups which operated under the name "Disaster Inc." All manpower and equipment were placed in a central pool. The local committee studied the emergency projects and assigned them to the cooperating contractors on the basis of urgency. Each job was inspected and approved as it was completed and payment was made to Disaster Inc. Large feeder mains and river crossings were among the facilities which were replaced in this manner.

The condition of water distribution systems varied considerably. The breakage of fire hydrants by bulldozers engaged in removing debris and silt from the streets constituted much of the damage. Systems which were contaminated only through the loss of pressure were easily disinfected by flushing and adding a few parts per million of chlorine. Mains which contained floodwater were flushed and then treated with from 50 to 100 ppm of chlorine for periods up to several days. As the water was being used only for sanitary and cleanup purposes during this period, it was possible to maintain the high residuals for a sufficient time to burn out accumulated slime growths and other deposits without consumer complaint. In some cities cleaning was so thorough that ammoniation could be discontinued and free chlorine residuals maintained at all taps. In general, the additional

chlorine was applied at the plant, especially in the smaller towns. Sterilization of the larger systems was accomplished section by section; adequate valving played an important part. Valve records for field use should give complete data on the type of valve and direction and number of turns for opening, and references should permit location of the valve at night or when covered with debris and water. Portable main sterilizers owned by the cities were supplemented by Public Health Service units.

### **Laboratory Control**

The boiling of water was continued in the cities in which the supply was either threatened or inundated until samples collected on two successive days were of satisfactory bacteriological quality. The State Board of Health engineers made daily visits to each of the cities to examine the progress being made in rehabilitation, to give assistance, to determine chlorine residuals, and to collect samples.

The samples were brought to the water laboratory by automobile on the day they were collected. The laboratory was operated on a 24-hr basis, and the results from previous samplings were given to the engineers before they started on their return visits each morning. This practice permitted prompt reporting to local officials without the necessity of trying to send the messages by overtaxed communication systems. More rapid detection methods, such as that promised by the molecular filter membrane, would have permitted the lifting of "boil water" notices 24 to 36 hr earlier than was possible.

### **Conclusions**

1. Disease epidemics are no longer a necessary companion of floods.

Kansas water works officials successfully prevented waterborne disease by effective practices in providing safe emergency supplies, disinfecting storage reservoirs and distribution systems, improvising treatment methods until permanent facilities could be restored, and dealing with the public.

2. The public can and will voluntarily cooperate in the conservation of water during emergencies, provided accurate reports are made of the latest developments affecting the supply. Drastic reductions in water use in several cities were accomplished by this method more easily and more effectively than by attempts at compulsory rationing.

3. Trailer-mounted emergency water purification units equipped with pressure sand filters proved to be superior for cities that could be reached by highway as they were preassembled, available for immediate use upon arrival, and easy to operate. Knocked-down, lightweight, diatomaceous earth filter units were valuable for isolated cities that could be reached only by air. More time was required to assemble them for service and to train local people to operate them.

4. Emergency equipment and supplies should be kept in several strategic locations rather than at a central warehouse to make them available to greater areas under transportation difficulties.

5. The two-way radio communication systems of the State Highway Commission, city police departments, and water utilities proved to be a vital factor in the success of emergency water works operations. More radio communication equipment is needed.

6. The value of good records was never more clearly demonstrated than during the floods. Maps, plans, and records of valve locations and plant operation were vital both to the regular

personnel and to outsiders called in to help. The records and reports of the State Board of Health were of material assistance in anticipating the needs of various communities for supplies and equipment.

7. The coordination of the activities of key federal agencies, such as the Corps of Engineers and the Defense Production Administration, with the state and local activities was greatly aided by the regional office of the U.S. Public Health Service. Any federal plan for disaster assistance should provide the same type liaison.

8. An improvised mutual aid program among neighboring cities worked very well in supplying both men and material. Better results might be obtained through a training program to familiarize water works operators with plants in adjoining communities, and by training more people within the city in water works operation. In most places volunteer labor was plentiful, but supervisors found it necessary to work days without rest. Under a more extended emergency, the recovery effort definitely would have been delayed because of the shortage of persons capable of directing the repair work and of operating the plants. The simultaneous work of protecting the plant, operating the plant, and providing emergency supply, followed by the additional and concurrent jobs of operating emergency supply and cleaning and repairing the plant is too great to be handled by normal supervisory forces.

9. Flushing of mains and disinfecting with 50 to 100 ppm of chlorine quickly restored contaminated mains to good bacteriological condition. In some cities that required the sterilization of the entire distribution system, additional benefits were obtained in the removal of slime growths and deposits

which made it possible to eliminate ammoniation from the regular treatment and to maintain free chlorine residuals at all taps.

10. To prevent leakage into clear water storage reservoirs and possible structural damage, new construction should be sufficiently high to be above both flood stage and high ground water levels created by floods. Structural damage occurred even to clear wells that were overflowing throughout the flood. The precaution of not installing clear-well drains or overflows except for hillside reservoirs proved to be a wise one, as it eliminated what otherwise could have been a serious source of contamination of treated water.

11. There is a need for more water storage capacity located far above the possible high-water area. A height of 1 or 2 ft above the highest previous crest is not enough. Flood crests on some streams exceeded the highest flow on record by 9 and 10 ft. Experience during the Ohio River flood in 1937 was similar; crests 8 to 10 ft higher than previously recorded occurred.

12. Greater reserve chemical feeding capacity is needed at water plants, especially for chlorine. Standby power should be maintained for both low- and high-lift pumps. Pumping stations need to be self-contained and as self-reliant as possible.

13. Adequate valving of systems played an important part in isolating damaged sections of mains and in sterilizing certain sections.

14. Those responsible for the location, design, and approval of water works facilities should reexamine existing standards and practices in the light of the flood experiences for possible improvement.

The skill and knowledge of the staffs of consulting engineers were responsible for saving several important water treatment plants. In addition, these staffs played an important part in organizing emergency water services, especially in the Kansas City area. The equipment companies and chemical suppliers did an outstanding job in meeting the emergency demand.

Finally, the authors wish to pay tribute to the tireless energy and complete devotion to duty of the water works men who fought this flood. Many of them ran great personal risks to assure their customers safe drinking water. In the history of the 1951 Kansas flood, one of the outstanding features among many heart-warming stories is the contribution of the water works profession to the prevention of disease and in enabling citizens and businesses to return quickly to the stricken areas.

### **Production and Distribution—R. G. Kincaid**

Between early dawn and 11:00 A.M. on July 13, the rampaging Kansas River divided the water consumers of the Kansas City metropolitan area into three general groups:

Group 1—Consumers who were furnished an adequate supply throughout the flood period. The only inconvenience to these water users, except for a reduction in pressure, was that

some had to boil all water used for drinking and cooking.

Group 2—Consumers who were beyond the range of available service because of either high elevation or remote location. This group of water users was entirely without regular water service for a period of two to six days, depending on whether the consumer lived within the city limits of

Kansas City, Mo., or in the most remote suburban area. Consumers in this group were compelled to obtain water at designated points of distribution—either fire hydrants or tank wagons. Consumers stood in line with tubs, kettles, jugs, and milk bottles to obtain water needed in their homes.

Group 3—Consumers whose least problem was whether or not water would run from their spigots. These consumers' principal concern was that their homes, with all their possessions, were under approximately 20 ft of turbulent river water. In the Armourdale district of Kansas City, Kan., approximately 1,900 buildings were subsequently condemned as unfit for further use. It seems very doubtful that the people included in Group 3 could understand the statement, "It could have been worse." After all of the facts have been reviewed, however, there can be but one conclusion: The battle to save the water supplies of Kansas City, Mo. and Kan., was won by a very slim margin.

A graphic story is found in the hour-by-hour and day-by-day accounts of the 1951 flood and its effect upon the Kansas City water systems as recorded by first-hand observers, including: M. P. Hatcher, Director; J. B. Ramsey, Chief Engr.; F. G. Weis, Asst. Chief Engr. and Supt., and J. R. Popalisky, Supt. of Purification—all of the Kansas City, Mo., Water Dept.; and R. J. Duvall, Manager of Production and Distribution; E. E. Chapman, Supt. of Water and Light Plant; A. W. Rumsey, Chemist; O. G. Kuran, Supt. of Distribution Mains; and J. C. Jordan, Supt. of Distribution Meters—all of the Kansas City, Kan., Water Dept. This paper is, to a very large extent, a report of the accomplishments of this group. The long hours which they and many other members

of their departments spent so effectively in meeting Kansas City's worst disaster played a vital part in the battle that saved the water supplies for approximately 800,000 people.

### Extent of Interruptions

Figure 1 is a map prepared by M. P. Hatcher of the Kansas City, Mo., Water Dept. to show the areas served by the three water works properties located in the Kansas City metropolitan area. The Kansas City, Kan., and Kansas City, Mo., systems have previously been described by Hatcher and Duvall (1).

The area actually covered by flood waters is relatively small in comparison to the total area served. The total area of the districts flooded in Kansas City, Kan., and Mo., including Argentine, Armourdale, Central Industrial, and Fairfax Industrial, was approximately 12 sq miles, whereas the total area served is approximately 400 sq miles. The area flooded in Kansas City, Mo., was less than 2 sq miles. This fact will doubtless come as a surprise to many who are not familiar with the topography of the area.

Figure 2 shows the extent of the flood within the metropolitan area and its relationship to the principal facilities of the water systems of Kansas City, Mo., and Kansas City, Kan.

In the Kansas City, Kan., system, the water plant, including the high-service pumping station, is located on the south bank of the Missouri River approximately 6 miles above the mouth of the Kansas River. The Argentine Reservoir, located on high ground across the Kansas River, acts as equalizing and emergency storage on the distribution system known as the Main Service. Booster districts serve the high ground in the west part of the city as well as that area adjacent to and

beyond the Argentine Reservoir. The principal trunk mains are indicated in Fig. 2. The only interruptions to service in the Kansas City, Kan., system were those brought about by the necessity of closing all valves leading into the flooded areas from both the pump-

shaft. From this point water flows to ground storage reservoirs located at Turkey Creek Station and East Bottoms Station through a 72-in. tunnel and 54-in. flow line, respectively. Both of these stations deliver water to a common distribution system, the Main

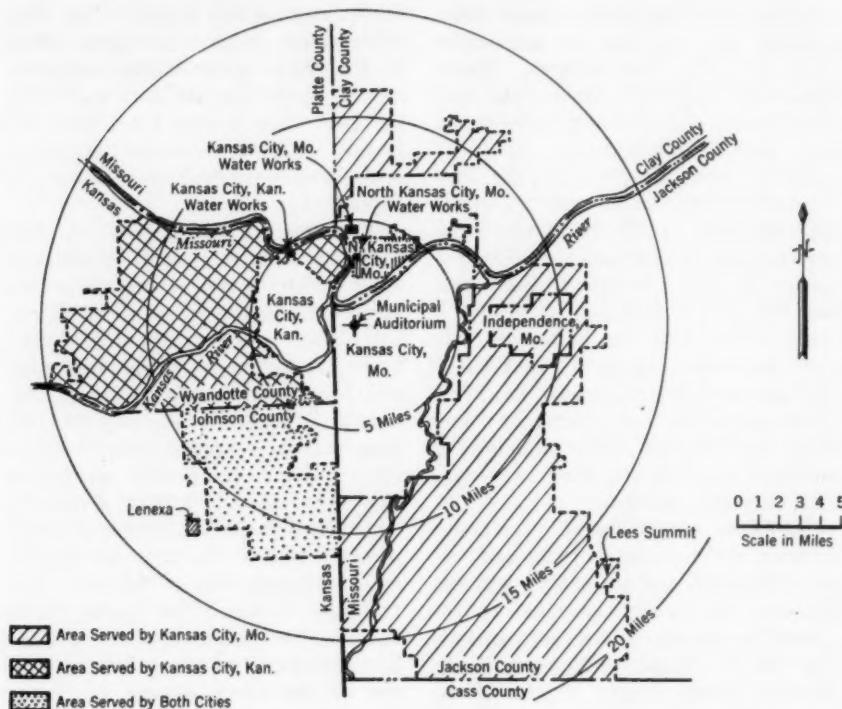


Fig. 1. Areas Served by Kansas City Water Systems

The total area flooded in Kansas City, Kan., was 10 sq miles, and in Kansas City, Mo., 2 sq miles.

ing station on the north and from the reservoirs on the south.

The Kansas City, Mo., water plant is located on the north side of the Missouri River approximately 3 miles above the mouth of the Kansas River. Finished water is delivered by low-head pumps through a 90-in. tunnel under the Missouri River to the uptake

service. A portion of the distribution system network is indicated in Fig. 2. A ground storage reservoir (not shown in Fig. 2) serving a booster district is located in the southwest part of the city. Water is also delivered at the city limits to the adjacent municipalities and water districts, as shown in Fig. 1.

Interruptions to service in the Kansas City, Mo., system were limited to a complete outage of the Turkey Creek Station by flooding, the impossibility of valving off the storage reservoir completely at that station, and the disruption of service in the flooded area of the Central Industrial district.

Figure 2 shows the extent of the flooded areas. The flooding occurred as follows:

Argentine—Levee overtopped at approximately 11:00 P.M. on Thursday, July 12.

Armourdale—Levee overtopped at approximately 5:30 A.M. on Friday, July 13.

Central Industrial—Levee overtopped at approximately 11:00 A.M. on Friday, July 13.

Fairfax Industrial—Flooded by backwater as a result of a storm sewer near the mouth of the Kansas River that ruptured at approximately 5:00 P.M. on Saturday, July 14.

Crest elevations are shown at the Kansas Ave. Bridge; 23rd St. Bridge; Hannibal Bridge; Kansas City, Mo., water works intake; and at the Kansas City, Kan., intake. As the peak flow of approximately 500,000 cfs passed through the Argentine and Armourdale districts a drop of approximately 4 ft occurred between the Kansas Ave. Bridge and the 23rd St. Bridge, a distance of approximately 3 miles measured along the river channel. The drop from the 23rd St. Bridge, which is adjacent to the Turkey Creek Pumping Station, to the Hannibal Bridge was in excess of 16 ft, most of which occurred above the mouth of the Kansas River in a distance of approximately  $2\frac{1}{2}$  miles. This excessively steep gradient was caused by the critical restrictions to cross flow in the Central Industrial district. The direction of flow in Armourdale was, in

general, parallel to the principal streets which, of course, accounts for the high velocities and extensive property damage in this district. The depth of floodwater varied from 12 to 30 ft in Armourdale.

It is interesting to note that the water surface between the intakes of the two systems was substantially level. This is due, of course, to the low discharge rate in the upper Missouri concurrent with the high stage created by the Kansas River.

#### Kansas City, Kan., System

Because of water main breaks in the flooded area of Armourdale, it was necessary to valve off all mains leading into the area from the source of supply on the north and from storage reservoirs on the south. Supply from the water plant was adequate at all times for the area located to the north and west of the flooded zone. Very limited service was available from storage to the isolated area south of the Kansas River. Within five days after service was interrupted, water was being delivered across the flooded area to storage. Within twelve days Armourdale was being supplied a limited quantity of water. The water plant was operated at full capacity for a restoration period of 30 days while leaky mains were being repaired in the flooded area.

Surprisingly little damage was inflicted on the distribution system even though most of Armourdale was submerged in more than 20 ft of floodwater flowing at high velocity. Actually there were only eleven major breaks in mains: one 24-in. river crossing, caused by extreme erosion of the river bank; six 16 in.; one 12 in.; one 10 in.; and two 8 in. Other damage to the distribution system caused by cleanup operations included twelve hydrants broken off, twenty hydrants requiring

minor repair, and numerous broken valve covers and roadway boxes. Approximately 2,400 water services were broken. The problem of locating, shutting-off, and repairing services was greatly complicated by the deposition of 6 to 30 in. of silt over the entire area and the shifting of many buildings from their foundations. Cleanup operations also greatly aggravated the situation.

key Creek Pumping Station as a result of the overtopping of the adjacent river levee. The station was forced out of service immediately. Water soon rose to a depth of 6 ft over the operating floor, thus putting out of operation approximately two-thirds of the high-service pumping capacity.

Immediately after the overtopping of the levee, pipeline crews were dis-

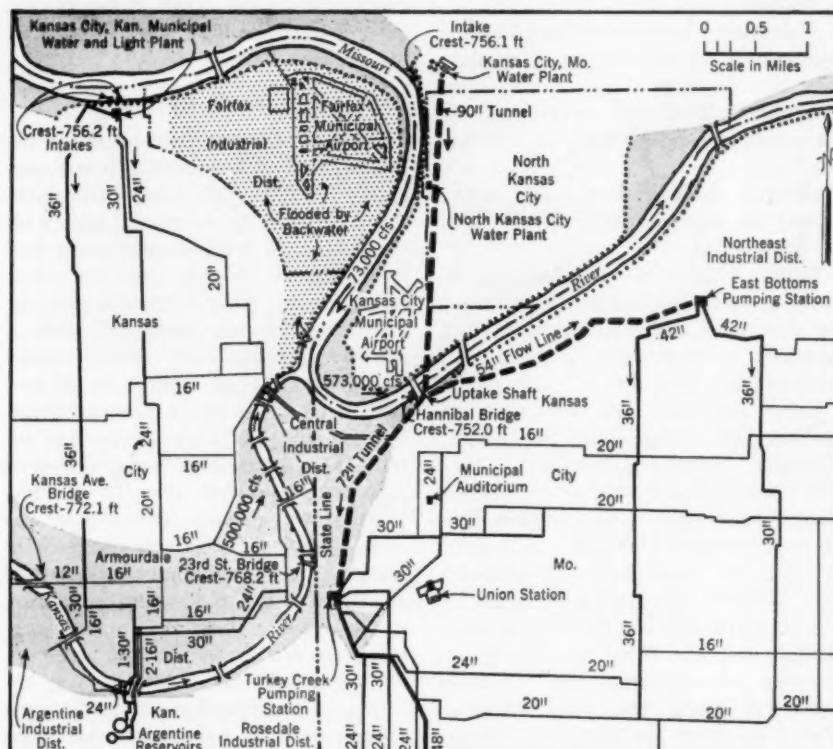


Fig. 2. Effect of 1951 Flood on Kansas City Water Systems

*The principal trunk mains and a portion of the distribution system are shown.*

### Kansas City, Mo., System

Figure 3 gives a day-by-day account of the effect of the flood on the Kansas City, Mo., system.

On July 13 shortly before 11:00 A.M., floodwater rushed into the Tur-

key Creek Pumping Station with instructions to close two valves which would isolate the storage reservoir at Turkey Creek from the supply system. The crews were able to close one valve entirely but were

forced by the rapidly rising floodwaters to leave the site before the second valve could be completely closed. Because of the partially open valve, potable water was being wasted into the floodwaters at the rate of 40 to 60 mgd. This waste, in turn, limited the rate

July 15. At that time a group of engineers from the water department was finally successful in closing the valve by working neck deep in the floodwater and "walking" the valve shut by operating a valve key with their padded shins.

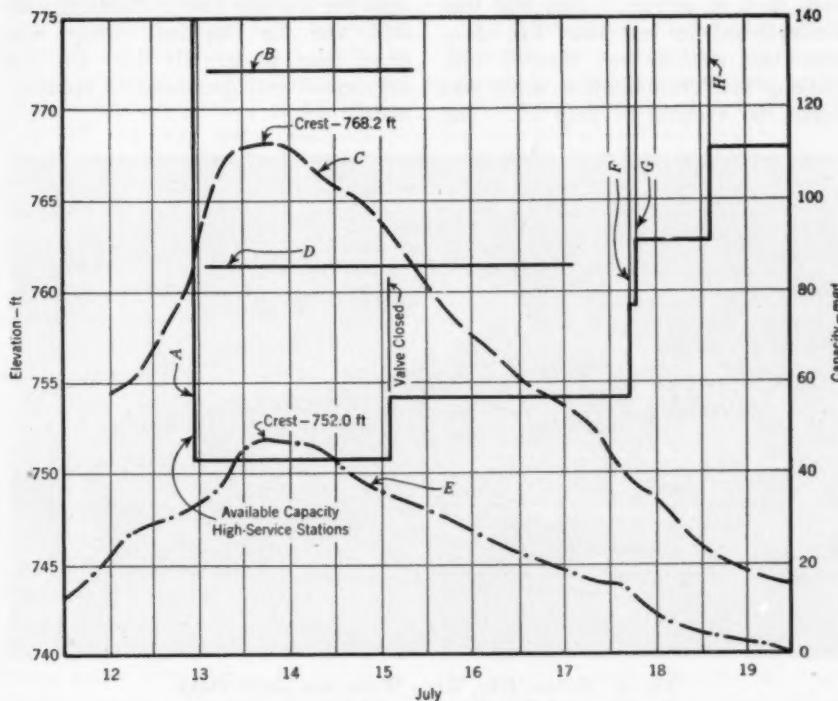


Fig. 3. The Critical Week During July 1951 Flood

The italic letters refer to the following: A—Turkey Creek Pumping Station Flooded; B—high water at Kansas Ave. Bridge, 772.1 ft; C—water level of Kansas River at 23rd St. Bridge; D—elevation of operating floor at Turkey Creek Pumping Station, 761.6 ft; E—water level of Missouri River at Hannibal Bridge; F—first pump returned to service; G—second pump returned to service; and H—third pump returned to service.

of delivery to the East Bottoms Pumping Station, and thence to the distribution system, to approximately 43 mgd, as shown in Fig. 3. In general, pressures dropped approximately 50 psi below normal. This condition prevailed until approximately 2:00 p.m.

After this valve was closed, delivery to East Bottoms Pumping Station was stepped up from 43 to 57 mgd. This added quantity and the resulting increase in pressure relieved practically all of the distress occasioned by lack of water or low water pressure.

The water level at the 23rd St. Bridge, adjacent to the Turkey Creek Pumping Station, is shown in Fig. 3. It is important to note that within a little more than two days after the floodwater had dropped to the level of the operating floor, the first two pumps were back in service. This feat was accomplished in less than five days after the station was flooded out. Cleanup and rehabilitation work was begun the evening of July 15. The

normal. The first turbine-driven unit was placed in operation within ten days after outage and the second unit within fifteen days.

The water level data in Fig. 3 show that at the time of the crest the difference in elevation at the 23rd St. Bridge, near the Turkey Creek Pumping Station, and the Hannibal Bridge was more than 16 ft. By July 19, this differential had decreased to approximately 4 ft.



Fig. 4. Kansas City, Kan., Water and Light Plant

main effort was directed toward the restoration of service by means of the triple expansion engine pumping units. The station has a total installed capacity of 135 mgd, including three triple-expansion engine pumping units, two producing 20 mgd, and one producing 15 mgd, and three steam-turbine-driven centrifugal units, two producing 30 mgd, and one producing 20 mgd. After the three pumping units at Turkey Creek Station were back in operation, water pressure throughout the distribution system became essentially

#### Day-by-Day Account

##### *Friday, July 13*

Immediately after the flooding out of Turkey Creek Pumping Station, the following restrictions on water use were publicized by radio and through the press:

1. The use of all water for commercial and industrial purposes was discontinued.
2. The use of water in homes was limited to sanitary and other necessary household uses.

3. The use of water for home laundry work, car washing, lawn sprinkling, air conditioning, and other similar uses, was discontinued.

4. Everyone was urged to boil all water used for drinking and cooking.

Suburban users were limited to 25 per cent of normal usage. The Kansas City Suburban Water Co., located in Johnson County, Kan., was unable to obtain water from the Kansas City, Mo., system after 6:00 P.M. on Friday, July 13, nor was water available to them from the Kansas City, Kan., system. All office and business establishments in the city, except those essential to health and food service, were requested to discontinue operations.

#### *Saturday, July 14*

Pressures continued to be, in general, approximately 50 psi below normal in the distribution system. Much of the south part of the city and the higher points in the remainder of the city were wholly without water. Late in the evening the water department established seven locations where water could be collected in containers. Storage tanks containing chlorinated water were established at two locations. The Kansas City Suburban Water Co. collected water throughout the day from the Kansas City, Mo., system in a tank wagon fleet for delivery to its 12,700 customers. The fixed limit for deliveries to all purchasers for suburban use was 10 gpd per customer. Because of vigorous protests, this order was changed to 25 per cent of normal use.

#### *Sunday, July 15*

A tank wagon emergency water supply detail was established to serve consumers in the south section of the city and at points of high elevation. The partially open valve connecting the supply works to the Turkey Creek

Reservoir was closed at approximately 2:00 P.M. and, as a result, it was possible to deliver a sufficient quantity of water from the East Bottoms Pumping Station to relieve practically all distress due to low water pressure.

#### *Monday, July 16*

All business and commercial establishments were permitted to resume operations with use restrictions on air conditioning, sprinkling, street flushing, and golf course fairways.

By Thursday, July 19, six days after the Turkey Creek Pumping Station had been flooded out, all special limitations on delivery of water for use outside the city were removed, and these customers were placed on the same basis as Kansas City, Mo., users. All other restrictions were gradually removed as additional units were returned to operation at Turkey Creek Pumping Station.

On Monday, July 30, Turkey Creek Pumping Station encountered an all-time high hourly demand of 93 mgd simultaneously with a demand of 40 mgd at the East Bottoms Pumping Station, making an all-time high hourly demand for the system. The principal cause of this high demand, even though the industrial load was still seriously curtailed, was the large quantity of water being used in cleanup operation in the Central Industrial district.

#### **Kansas City, Kan., Water and Light Plant**

Considerable concern developed after the Fairfax Levee was ruptured near the mouth of the Kansas River. Through this breach in the levee, the Fairfax Industrial district was almost completely flooded by backwater.

Figure 4 shows, in the foreground, the flooded area of Fairfax. The main levee protecting the plant can be seen

at the right of the plant area. Secondary levees were built to prevent the backwater from reaching the water and light plant. The water plant is in the background beyond the power plant.

The work on the secondary levees was initiated approximately 24 hr before the break in the main levee. Although the floodwaters were prevented

### Kansas City, Mo., Water Plant

Figure 5 shows the Kansas City, Mo., water works. The levee was constructed between the water purification plant and the low-service pumping station, leaving the latter completely unprotected. The road leading to the intake and pumping station was under water at the time of the crest.



Fig. 5. Kansas City, Mo., Water Plant

from entering the plant area, it is very doubtful if the backwater would have affected operation of the water and light plant. The primary benefit of the secondary levees was to eliminate fire hazards which were critical in the Fairfax area because of floating oil and gasoline from refineries.

The principal precautions against flood hazards to the facilities inside the levee included:

1. Certain drain lines were plugged to prevent backwater from entering the plant.
2. The clear-well overflow was blocked off with sand bags.

3. As filters could not be washed satisfactorily during the highest river stages, all filters were washed on Thursday, July 12, in anticipation of three days without filter washing.

Had either the north Kansas City levee or the Municipal Airport levee failed, there would have been danger of contamination of the entire water supply. The gravest danger of a complete outage of the Kansas City, Mo., water supply was occasioned by the near failure of the low-lift pumping station located on the river side of the levee. The threatened failure was created when cracks formed in the wall of the pump pit nearest the river.

Engineering studies had been made previously to determine ways and means of protecting the intake and pumping station against floodwaters as high as the top of the levee, or approximately 6 ft above the present operating floor. Calculations indicated that it was not feasible to attempt to reinforce the existing structure and that any flood exceeding that of 1943 would stress the wall reinforcing steel dangerously near the elastic limit. The water level of the 1943 flood was approximately 9 ft below the operating floor. By Thursday afternoon, July 12, the flood level had already reached an elevation higher than the 1943 level. The story of the day and night vigil at the intake and pumping station on Friday and Saturday, July 13 and 14, is presented in the form of a direct quotation from the author's diary:

Shortly after noon on Friday 13, Mr. Hatcher called advising that Turkey Creek Pumping Station had already been inundated and requested me to proceed immediately to the low-service pumping station and discuss with the Water Dept. engineers what action should be taken as the river stage continued to rise. Before

reaching the site at about 3:00 p.m., I heard a radio report in which a crest of 32.5 ft was predicted. Actually the crest rose 3.8 ft above that figure.

The water level adjacent to the station walls as determined by auger borings was about 4 ft 6 in. lower than the river stage during Friday afternoon. This differential was maintained until the river reached a point about 1 ft below the surface of the driveway around the building. Further rise soon reduced this differential to 6 in. or less. At about 3:00 a.m. Saturday I felt a slight vibration while standing on the entrance steps. Upon inspecting the south wall of the pit I found that two cracks had formed in the riverward wall. Foamy water was coming through. At that particular time one of the five pump motors had been removed from the pit and a second motor was attached to the crane hook ready for removal. The three remaining pumps were enclosed in welded steel structures designed for operation in a flooded pit. Since much of the welding operations had been hurried and incomplete, it appeared doubtful that service could be continued if the pit were flooded.

The vital decision was at hand—should the pit be flooded or should a gamble be taken on the questionable strength remaining in a cracked wall? The water was within less than 2 ft of the operating floor but the crest was very near. It was decided to "ride her out" come what may—and the walls held. Thus the water supply of over 600,000 people was not blotted out. It was most fortunate that the water at the pumping station acted much the same as a huge lake on a calm day since the main flood discharge occurred approximately three miles downstream at the mouth of the Kansas River. A strong wind, however, could have piled up waves high enough to flood out the station. . . .

The conclusion to be drawn is that there is a vast difference between a water shortage and no water at all.

The 43-mgd rate of supply to Kansas City, Mo., consumers during the critical two-day period would seem most abundant in comparison to no gallons per day for an extended period.

### Safeguards

At Kansas City, Kan., consideration is being given to the construction of a permanent secondary levee to protect the water and light plants from back-water through the Fairfax Industrial district. The principal trunk main located under the Kansas River and supplying the Argentine Reservoir has been repaired in a manner that will prevent outage from future floods.

At Kansas City, Mo., several safeguards are being developed:

1. The construction of a new intake and pumping station, as contemplated before the flood. Bonds have been voted for this purpose.
2. Construction of facilities to reclaim wash water when and if desired. These facilities would be available dur-

ing high river stages to insure uninterrupted filter washing. This improvement is a part of previously contemplated modifications to the purification plant.

3. Construction of a third high-service pumping station near the south uptake shaft of the Missouri River tunnel. This station was suggested before the flood for summer operation to handle the air-conditioning load in the downtown area. Plans should be expanded to include the housing of valves at the uptake shaft and should be arranged so that these valves would be accessible during a flood such as that of 1951.

4. Studies are under way to determine the feasibility of providing separate flood protection for the Turkey Creek Pumping Station.

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## The Wisdom of Dams Without Gates

*By Arthur E. Morgan*

*A contribution to the Journal by Arthur E. Morgan, President, Dayton-Morgan Eng. Co., Yellow Springs, Ohio. Dr. Morgan was chief engineer of the Miami Conservancy Dist. during planning and construction of the project upon which this discussion is based.*

THE first steps toward formation of the Miami Conservancy Dist. were taken out of the wreckage of the city of Dayton, Ohio, immediately after the disastrous flood of 1913—a flood which did more than \$100,000,000 worth of direct property damage in the valley of the Miami River. Ten years later, following pioneering jobs in legislation, engineering, financing, and many fields of human relations, the district had provided the Miami valley with flood protection works that included river improvements at nine cities and dams on the Miami River and four of its tributaries. The story of that ten years of unremitting struggle against obstacles raised not only by the nature of the problem itself, but by other interests in the area and by the economic dislocations of World War I, has been told in detail elsewhere (1). Of particular interest to the water works profession is the type of dam used on the project.

The dams of the Miami Conservancy Dist. were almost without precedent in that they have no gates, but, instead, permanent openings through which water can flow at all times. Figure 1 shows the outlet conduits of the Germantown Dam, one of the Miami Conservancy dams, during ordinary stage, and Fig. 2 shows the same dam during flood. When these dams were built

there were two or three very small structures in the United States operating on somewhat the same principle, and in France, two man-made narrowings of the Loire River channel, dating back some centuries, provided similar action although they were intended for entirely different purposes.

In the more than thirty years since the construction of the Miami Conservancy works, no other great project has adopted this type of protection. During these years, a "conservation" wave that, in its more extreme tendencies, has found water power almost universally feasible and desirable, has swept over the country. Those responsible for the design of the Miami Conservancy dams have been severely criticized for not making water power development possible in the future. There has been national propaganda urging the federal government to take over the project and make it a unit in a national conservation program or a program for flood control on the Ohio and Mississippi Rivers.

### Engineering Review

Under these circumstances, in 1944, it seemed desirable to review the design of the Miami Conservancy dams to ascertain how those who had an intimate part in the project judged their engineering decisions of more than a

quarter of a century ago. That the design had not been generally used since then was not considered significant. The essence of good engineering is that overall design is not bound by precedent, but uses those methods that, of all possible methods, best fit the case. Unusual problems demand unusual solutions. Thus, there were two questions to be answered in the review: Are the plans that were used in this project the best that could have been devised under the conditions? Have the conditions changed sufficiently to justify any present or probable future modifications of those plans?

In 1944 when the project was reviewed, twelve of the engineers who had chief responsibility in the design and construction of the Miami Conservancy project were still alive and most of them were still in active practice. Inasmuch as almost all twelve, in the years following their work on the Miami dams, worked on dam designs for flood control, they had had an excellent opportunity to appraise the Miami Conservancy design in the light of their later practice and the retrospect of a quarter of a century. On this basis the twelve engineers were sent briefs of the arguments for and against gates and were asked whether they would again use the same type of dam if they were given the job of designing the Conservancy works in 1944.

In their replies, all the engineers pointed out that the type of dam in any project must depend upon the specific conditions encountered, and eleven of the twelve were still of the opinion that the conditions of the Miami had been and were still favorable to dams without gates. A clear appraisal of the advantages and disadvantages of dams without gates was obtained from

the various arguments of these twelve engineers.

### Safety

As safety is "the backbone consideration of flood control," it is the primary basis upon which such a project as the Miami Conservancy Dist. must stand or fall. From the standpoint of safety, it may be argued that gates are favored because they permit manipulation of discharges to coordinate the flow through the dams with downstream conditions and that, following a flood, they make it possible to empty reservoirs more quickly in preparation for a second flood. In addition it may be pointed out that, if desired, gates can be locked in position to permit operation of a dam on a retarding basin principle until gate manipulation is found necessary. In favor of dams without gates, on the other hand, are the very real advantages of automatic operation, in no way subject to human or to mechanical failure.

The proper manipulation of discharges by gate operation during flood periods is based upon several presuppositions: [1] an elaborate flood forecasting system that will give adequate information on where, when, and how much water will flow; [2] gate operators who understand the significance of flow data and how to act upon them; and [3] gates that will function when needed. Even an adequate forecasting system will be of little use on small drainage areas that are subject to flash floods. And no matter how accomplished, the personnel responsible for gate operations will be unable to undertake the intricate manipulations that are required in the absence of reliable information or of machinery that operates properly. Actually because the gates

on normally dry flood control dams are so rarely operated, their mechanical condition at infrequent times of need is always subject to suspicion, and, because the gate operators have so little to do, it is almost impossible to obtain competent personnel for the job or to keep them alert in the face of so much idleness. Mechanical fallibility and human fallibility are the basic weaknesses of flood control by gate operation. In addition, gates can be the invitation to political pressure for exploitation of

tem such as that of the Conservancy Dist. is also pre-established and is not subject to tampering for any reason, good or bad. As proper timing of the intricate manipulations of gates in a series of dams or relatively small drainage areas such as those of the Miami Conservancy Dist. can usually be determined only by using the data available after a flood has passed, the pre-established integration afforded by gateless dams is not only more dependable but of more real value than the theoretically

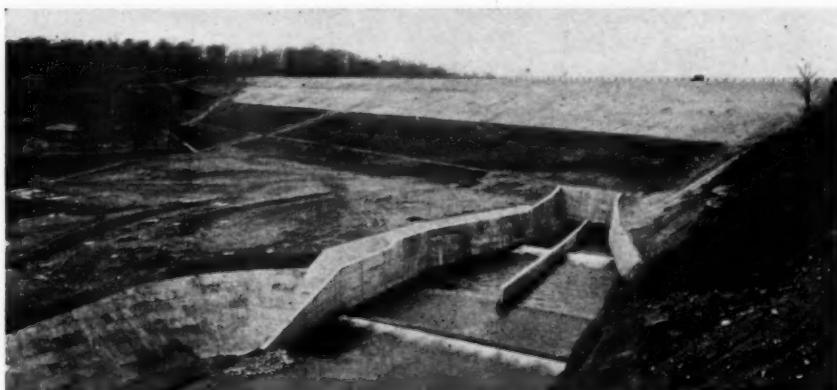


Fig. 1. Outlet Conduits of Germantown Dam During Ordinary Stage

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flood control dams for power, recreation, and other uses antagonistic to their primary purpose.

The automatic operation of gateless dams requires human participation only for the minor maintenance work necessary to keep the structures ready for their job. Flood discharges begin with the beginning of rainfall and are free-flowing to a pre-established maximum. Integration of the amounts released from the various dams in a sys-

more accurately timed gate control. As a matter of fact, the hindsight demonstrations of error in handling gates during floods suggest that only the federal government could with impunity take the risk of costly lawsuits involved in releasing floodwaters from any dam not filled to the spillway. The dry dams of the Miami Dist. were designed for the maximum flood, and their outlets for the combined release of the maximum amount of water that the

river system below could handle. Thus, in being beyond the control of human agencies, the dams are also beyond both the criticism and the influence of downstream interests.

### Multiple Purposes

One of the persistent criticisms of the Conservancy dams has been that the absence of gates deprives the valley of power and recreation facilities that would have been feasible with conventional design. Inasmuch as use of

clearly not justified by the physical characteristics of the drainage area involved. As the valleys above the dams were fertile and flat-bottomed, the agricultural land that would have been lost by power storage was worth much more than the power to be derived. In addition, recreational uses, although they have become more important since the dams were built, could not, then or now, justify gates. Small lakes can be provided—and one has been provided at one of the dams—at much less cost



Fig. 2. Outlet Conduits of Germantown Dam During Flood

the dams for such other purposes would be incompatible with their use for flood control, the value of power and recreation facilities was carefully assessed in the original plan. Strangely enough, when the project was being considered, some of the strongest opposition to it was based on the argument that the Conservancy plan was merely a trick by which the utility interests intended to build power dams.

As far as power potential was concerned, the provision of gates was

and with practically no effect on flood storage capacity by providing separate small dams in the flood basins above the main structures. Such separate units provide recreational facilities without the possibility of, or excuse for, excessive encroachment on flood storage capacity.

Other than power, recreation, and regulation of low water flow, no other additional purpose has been seriously suggested for the Conservancy dams. Other needs can best be met by addi-

tional small dams. Had other purposes been suggested, the same test of possible conflict with usefulness in flood control would have been applied. Perhaps the best evidence of the engineers' position on the subject of multiple uses is expressed in the words that are carved in granite at each of the dams: "The dams of the Miami Conservancy Dist. are for flood prevention purposes. Their use for power development or for storage would be a menace to the cities below."

Continued uses of the flood basins which were not antagonistic to flood control were made, of course. Among these uses are farming by the land-owners who had granted flood easements, forestry by district forces, and the establishment of recreational parks on the dry flood basin lands owned by the district. The thin layer of loam deposited in the basins by the floods that usually occur in winter and early spring enriches the soil and results in a higher rental value for the lands subject to overflow than the lands not flooded obtain. During all the years since the dams were built, less than 1 per cent of the crops in the basins have been lost by flooding. During the years when counts were made, the Conservancy parks had more visitors than some of the national parks. Thus, the criticism of wasteful use of land is not well sustained.

### Costs

Costs are often equally as important as benefits, but they were not a decisive factor in the plans of the Miami Conservancy Dist. The best possible protection was sought, and necessary costs were questioned only as they related to a choice between means of providing that best protection. Safety dictated dams without gates when dams

with gates might have required the provision of less storage capacity and, thus, might conceivably have cost less.

Although detailed cost comparisons were not made and it was assumed that conventional dams would have cost less, it is likely that, in the long run, the omission of gates reduced costs despite the possibly increased size of dams and flood basins required. Against the cost of the additional storage capacity must be balanced the cost of the gates themselves, the capitalized costs of their maintenance and operation, and the cost of providing the elaborate flood warning service required in their use. Furthermore, it may be pointed out that the cost of flood easements in the basin above the dam would undoubtedly have been much higher if gates had been provided.

Not costs themselves, but costs measured against what is wanted and what can be obtained must be the real measure of such a project. The late Daniel W. Mead, one of the consultants on the Conservancy project, said: "The degree of protection afforded by these plans is, in the judgment of the writer, comparatively small in cost at a price of less than one-tenth of the actual and consequential financial loss entailed in one great flood, and this without taking into account the safety of life assured to those who live on the flood plains of the stream."

### Conclusions

In spite of the emphasis of the preceding arguments, it is not intended to suggest that dams without gates are better than dams with gates for any other specific project. For obvious reasons, dams with gates have much more general application and greater flexibility. All but one of twelve engineers who were responsible for the

Miami dams as well as other flood control works all over the world, however, concluded that dams without gates are definitely useful in flood protection and are superior for the Miami Conservancy project. In reaching this conclusion, all the engineers have indicated that the specific conditions of any given project must determine whether or not such dams will be more useful than conventional dams. Some of the conditions in the Miami Valley that made gateless dams seem the most appropriate include the following:

1. The drainage areas are so small and the discharge into the basins so rapid that the only useful flood forecasting would be that obtained directly from rainfall by men of long experience and quick judgement. Thus, automatic flow control is a great deal more dependable than control by man-operated gates.

2. Not only the impossibility of obtaining adequate flood data, but the speed with which flood could follow rainfall, made effective, accurate, and synchronized manipulation of the discharges on five streams by personnel and equipment called into action on only rare occasions just about impossible.

3. The valuable agricultural lands in the flood basins of the dams made it wisest economically to use a design that would permit their maximum use.

4. The Miami project embraced a single, localized area that was primarily interested in flood protection and intended to pay its own bill for the protection provided.

Throughout this discussion, as throughout the development of the

Miami project itself, the limitation of the dams to flood control, except for incidental uses such as recreation, has been emphasized and reemphasized. With that limitation in mind, few, if any, engineers acquainted with the Miami valley situation would argue against dams without gates. The basic argument is with the limitation. Only occasionally is flood control so dominantly the controlling purpose of an improvement as was proper in the Miami valley.

The success of the Miami Conservancy Dist. system over the past 30 years, during which floods have come and gone almost unnoticed by the people of the valley and have caused a crop loss in the flood basins estimated at less than 1 per cent, certainly seems to indicate the wisdom of dams without gates for the Miami valley. Although the conditions found in the Miami valley will not be duplicated exactly elsewhere, it would be poor engineering to omit arbitrarily inquiry into the feasibility of dams without gates, especially for projects intended primarily for flood protection. Although dams without gates are only occasionally suited to the grandiose multiple purpose projects of today, they are sometimes appropriate as elements of such systems. Also, there are places for dams without gates within far-flung river control systems in which local systems are planned and executed for their local value alone.

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# The Future Course in Water Management

By Arthur H. Carhart

*An address presented on May 6, 1952, at the Annual Conference, Kansas City, Mo., by Arthur H. Carhart, Denver, Colo.*

**W**HERE do we start in trying to forecast the future in water resource management?

If we ever hope to arrive at sound management of our water wealth, we must not approach the problem from the viewpoint of any specialized segment of the whole. That has been the trouble. The high priests of some technical specialty have ballyhooed their particular activity as the predominant or inclusive answer to water management.

We must approach water resource management from the most fundamental foundation we can establish. We should utilize the skills in all the specialized fields bearing on these problems, but we must apply activities in each field in balance and in coordination to secure the greatest total good.

## Water Demands

First, what will be the demands on our water wealth? Actually every 24 hours an average of about 1,300 gal of water is in use to maintain living standards of each person in the nation.

A ton of finished steel requires about 65,000 gal of water in processing; synthetic rubber production uses 600,000 gal per ton of product; and paper pulp uses 60,000 to 70,000 gal of water per ton of pulp produced. Just ahead lies the prospect of hydrogenation of coal to produce petroleum products. A plant having a daily capacity of

10,000 barrels of petroleum would use  $5\frac{1}{2}$  to  $6\frac{1}{2}$  mgd of water, 80 per cent of which would be consumed. We could stack up many more figures to indicate the demands of industry on our water bank.

But there is a far more startling picture when we turn to crop production. We don't think of this withdrawal from our water bank account very often, but next to maintaining body moisture, food production is the most elementary of all water uses. Experiments have shown that an acre of wheat growing in the plains country requires 565 tons of water to produce 1 ton of dry matter. That isn't the grain alone; it is the total dry matter in root, stem, leaf, and grain. The water ratio in growing an acre of clover is 797 tons to 1 ton of dry matter. Beans require 736 water tons to 1 of dry plant. Alfalfa's ratio is 840 tons of water to 1 ton of dry matter. And it was found that an acre of corn growing in Kansas uses 324,000 gal of water in the crop year.

Ahead of all other water uses are these two—water to drink and water in the soil to grow food crops. In whatever we may do to conserve and utilize our water resource, we must recognize that water and soil are inseparable in fundamental natural resource planning. Soil plus water plus sunshine are the simple things that underwrite life on this earth.

Only one-fourth of the earth's surface is in land masses. But only a portion of this land is capable of producing crops and other earth-grown human needs. In these United States there are about 1,903,000,000 acres. But, subtracting deserts and other non-productive surfaces, we have only a third of that total—about 610 million acres—in cropland. Already we have lost, largely through destructive erosion by water, 100 million of those acres. Above any other consideration in future water management, is that of what happens to or in the soil on which the raindrop falls. The pressure on these two essential resources is increasing enormously.

The 1790 census showed about 4 million people in the nation. In 1840 there were over 16 million; in 1940 there were 130 million. Scientists believed that the population would level off in 1947 at 140 million. It's now over 155 million, and the forecasters are anticipating this country will have a population of 200 million at some date between 1970 and 2000.

It is imperative that the best attainable water management shall give primary consideration to the soil-water combination. For the land surface and the precipitation that falls on it are, in truth, the elementary part of the mechanisms we must manage to conserve. The greatest use of values from our water wealth must be secured.

Instead of giving these primary natural mechanisms priority in our planning and action, we have been dazzled by a stupendous program of structural, man-made projects that are puny in comparison with the facilities in water management nature herself supplies. And there is a rising awareness among citizens that our dollars

could be far better spent in other quarters than in the big federal dam program that is now being so zealously promoted.

### Federal Projects

In the *Congressional Record* of August 12, 1949 a report prepared by the Army Corps of Engineers stated that federal agencies had plans, proposals, and prospective projects, which, if all completed, would cost an estimated 53 billion dollars. Invariably such first estimates mushroom—they sometimes total nine or ten times the estimate made for a project when Congress authorized it. The Colorado Big Thompson project of the Bureau of Reclamation, for example, was authorized on an estimate of 44 million dollars. It is expected to cost 200 million by the time it is completed. It is called an "irrigation" project. It will irrigate no new lands. Its irrigation facilities will furnish supplemental irrigation to some 700,000 acres already under ditch but with existing water delivery systems built beyond the capacity of readily available sources of supply. The project will cost 200 million dollars. The irrigation users have contracted to pay back 25 million—no more. The only hope of paying out the remainder of the cost incurred lies in power. In fact, this is a power project, like most others now proposed, masked as an irrigation scheme.

Based on the Bureau of Reclamation's own figures, and adjusting these for increased costs since their estimate was made, the cost of the power producing feature of the Big Thompson should be 106 million dollars. Even if all of that allocation were to be recovered through the sale of power, it still would leave 70 million to come out of

some other source, and that source, is the taxpayer's pocket.

Very well, let's take the 106 million dollar figure as the cost of the power features of the Big Thompson. And against that, set up this fact: a public service company in the same area just completed a steam plant costing less than 23 million dollars that has the capacity to deliver over twice the firm power annually that the Big Thompson can deliver.

The private company now sells electricity in the area at approximately 1 cent per kw-hr. A spokesman for the Bureau of Reclamation recently announced Big Thompson power would be sold at 7.1 mills per kw-hr. But the established corporation pays out about 4½ mills of its 1-cent charge for taxes. On a tax-free basis, the commercial company could beat the federal power charge, and still make a profit. And don't forget that some 70 million of the cost of the Big Thompson project isn't charged against either irrigation or power and is, in truth, a subsidy out of the taxpayer's pocket. Project after project subjected to honest analysis almost certainly would blow to splinters the mirage of federal hydroelectric power's being cheap. The greater part of the pay-back of federal dam costs is loaded on the power sales. And without the power feature, a vast majority of these projects never could be "justified" even to Congress.

Finally, it is necessary to supplement these public power jobs with standby steam plants. The full capacity of a hydroelectric plant occurs during high water times of spring and early summer when the load is lightest. When water for hydro power is low in the autumn and winter, the load is heaviest. So, to have the hydroelec-

tric installations operating at capacity when they can, we have to have steam plants to take over in peak-load periods of autumn and winter.

#### Agricultural Acreage

What about the need for tax money subsidizing the so-called cheap power to subsidize irrigation, to "make the desert bloom?" Well, we have some 500 million acres of good agricultural land. At the very maximum, with billions to spend on irrigation schemes, we might add 16 million acres to our croplands. They'd be good acres—at least until the alkali salts concentrated in them to lower their value. But 16 million acres isn't going to solve the problem of keeping crop production in pace with population increases—not by a long shot. While we might put 16 million new acres under ditch, we are losing an estimated 500,000 agricultural acres a year principally through bad land management in relation to water. It would seem far more sensible to apply dollars and effort to stop the theft of fertility from lands already under cultivation than ignore that progressive robbery and throw funds toward irrigating new acres.

Actually, it has been stated that by applying known techniques to lands already under tillage, we can increase crop output from five to ten times our present level. This can be accomplished by better soil and water management, more highly productive crop species, and building soil fertility. We've already lost 100 million acres of agricultural land through misuse and abuse. Just to indicate the magnitude of this soil theft, it amounts to three billion tons per year.

What floods steal is indicated by the estimate that when the Mississippi is

running at its peak, it dumps enough silt into the Gulf every 60 seconds to cover a 40-acre field 8 in. deep. Most of that silt is topsoil, permanently removed from our acres that must increasingly produce to support our standard of living. And most of it is stolen by unmanaged water.

### The Masked Dam

Before we get away from the silt factor, with the sharply apparent fact that dams cannot in themselves halt the land robbery it represents, there is a warning I want to convey, particularly to any resident in the Missouri Basin. It concerns the masked dam that is started whenever and wherever a big main-stem dam is completed. This masked dam threat is showing up as one of the most terrifying features we must consider when we weigh the question of whether or not our dollars and work go into the 53-billion-dollar federal program and the monster dams that are a key part of it.

A dam blocks the natural current of a stream. A retarded flow cannot transport the silt it is carrying. It drops this load. And at the head of every reservoir that may be formed in back of a big main-stem dam, a hidden dam begins to build. Let me tell you the story of the Rio Grande River in New Mexico. It's a case history of this menace of the masked dam.

In 1880 the Rio Grande Valley within New Mexico had 124,800 acres under irrigation—fertile bottom land. About that same time hordes of cattle and sheep swept in to graze the watersheds of the Rio Grande and its tributaries. Progressively, the retention value of the hill slopes was destroyed. Side streams had been meandering creeks. In 1853 a man named C. E. Pancoast recorded in his diary that he

crossed Gallisteo Creek south of Santa Fe on a single plank thrown from bank to bank.

The loss of ground cover on these critical slopes allowed porous surface soil to be skinned away. Exposed mineral soil eroded more rapidly with each rain. Streams, when they ran, became liquid sandpaper. Today Gallisteo Creek is a roaring flood when it rains, and a sandy flat at other times, nearly a quarter of a mile between cut banks that stand sheer 10 to 30 ft above the gouged-out channel. That, in some degree, happened on all tributary basins where the soil was so abused it had no retentive value left.

Silt poured into the Rio Grande channel. The lower gradient of the stream, after it emerged from the mountain country, allowed the silt to settle. The stream bed began to aggrade. This aggradation was aggravated by the construction of Elephant Butte Dam over 150 miles south of Albuquerque. Construction began about 1914 and it was put in service in 1917.

A hidden dam at the inlet to Elephant Butte Reservoir began to form. A marsh area and four lakes formed above the hidden dam. That further slowed the water. By 1936, the silt settling upstream from the reservoir had built up the river bed 13 ft. The town of San Marcial, some 20 miles upstream, that had a population of 1,000, was abandoned; the railway had to raise its tracks time and again. All up the Rio Grande the river bed was built up. The bottom of the river was higher than the surrounding farms. These became waterlogged. Fifty miles above Elephant Butte Reservoir, the rise in the river bed between 1927 and 1936 averaged 9 ft. Of the 124,800 acres of land that had been irri-

gated in 1880, 80,000 acres were abandoned entirely because of an aggraded river channel causing waterlogging.

For months past, Albuquerque has been looking to the high basins of the Rio Grande where a record snowpack is recorded. Why? Because the bottom of the river bed at Albuquerque is 4 ft above some levels in the business section of that city. If the snowpack melts swiftly, and sandy dikes that are makeshift fortifications against flooding of the town ever break, nothing can stop a flood disaster in parts of Albuquerque.

What have federal bureaus and Congress offered as the answer to all this? Congress has approved a 100-million-dollar joint scheme of Army Corps of Engineers and the Bureau of Reclamation—the Middle Rio Grande Project. And what is that scheme? A ditch through the hidden dam at the head of Elephant Butte, so the silt can flow on through and fill the reservoir capacity at the rate of some 23,000 acre-ft a year. It will require continuous dredging if that channel is kept open. Three big dams, also, with a silt storage of some 300,000 acre-ft provided above them are part of this scheme.

Dam, dike, drain, dredge—the futility of it all has already been demonstrated right before their eyes—the scouring of silt off the damaged watersheds. While the damaged land pours flood and silt into the Rio Grande, the engineers wait downstream to control it, and little or no attention is given to preventing what's happening.

The hidden dam at the head of Elephant Butte Reservoir is the proved example of what happens to a river valley above a concrete dam blocking the main stem. It's a blazing example of neglecting the natural machinery of water management that lies in the

watershed and applying only the engineering-constructional approach to downstream dam building. In every reservoir below a silt-bleeding watershed, the silt menace is progressively destroying storage capacity. Lake Meade above Hoover Dam is receiving 100,000 acre-ft of silt a year. But far more important than siltation of the reservoirs is this new-recognized threat of the masked dam at a reservoir's head, and the progressive aggrading of the river channel above that point.

If you wish a demonstration of what happens above a big, mainstem "flood control" dam, dig up the facts about last year's flood above Grand Lake in Oklahoma. At flood peak the height of water at the upper end of the lake was 28 ft above the level of the dam that formed the lake. The dam surely caused the flood above it. The loss here was set at 5 million dollars, and one man was drowned.

Harold Munger, noted hydraulic engineer of Kansas State College, has stated that siltation of a prairie stream with a maximum gradient of 2 per cent occurs progressively for as much as 200 miles above one of these main-stem dams. The aggradation tends to build up parallel to the existing bed of the stream, and it builds at a height equal to the height of the dam.

Is there sense or reason in building a dam, to "control" floods, that will cause the formation of the masked dam at the head of a reservoir—a hidden dam that will cause the stream bed to rise slowly until it is higher than the farms and towns adjacent to that stream?

#### Need for Reorientation

There is a place for the constructional phase, the dam, in water management. Engineering is a vital part;

it can contribute in invaluable ways to an overall management of the water resource. We've reached a point where we must, positively must, reorient ourselves, all across the board, with regard to water resource planning and policy.

At the very base of any possible water delivery lies the watershed. Look at it as a mechanism if you will—slopes of earth that make catchment basins to gather and deliver water for our use. There is where our water wealth, both surface and ground water, is gathered. Water management must start at the ridge-pole of divides between basins and continue all the way down the basin. There's where our future planning must start. Water is continually on the move. It cannot be held in fee title by anyone. Any attempt to box it up, hold it intact, is thwarted by natural forces such as evaporation, percolation, and outright travel down the stream bed.

We can confer the right to use water and only that. The right to use does not confer the right to abuse or destroy. And the more times and the more ways we can use water from raindrop to river's mouth, the greater wealth and service it can produce.

The essence of good water management planning must start at the point where the raindrop hits the earth. A soil which can absorb water, allow it to percolate, is the primary piece of mechanism in water management. A trapped raindrop will not rob the top-soil, rush to the main channel, carry silt into the stream, and build its multiple body into a flood.

A watershed that holds back water first underwrites crop production by supplying soil moisture. It puts the overage that is absorbed into precious ground water reservoirs. This overage then comes out as springs and

seeps in many places to maintain mid-season stream flow, water that is not on the loose. It is clear and controlled and highly useful.

May I submit that if the slopes that poured the Missouri flood into the river had caught and held back as little as 2 in. of water per watershed acre, the top of the flood, the destructive peak, would have been knocked off and the desperate, heartbreaking fight to control the flood at its raging height would not have been necessary.

### **Watershed Development**

The first step is to approach the watershed as nature's existing gigantic reservoir to be so managed it will catch and hold, for use, all water that can be absorbed in the ground reservoir.

At this point there is sure to arise the cry that there always have been floods, that these watersheds always produced floods. Granted. But the tragedy of lost water, of water gathered into destructive power and mass, is increasing rather than diminishing, and that is because watershed absorptive values are lessening through mishandling of surface soil. If we have the brains we proudly proclaim we have, haven't we the ingenuity to increase the retentive potentials in a watershed to double or treble what it had in the virgin state?

As a step to add to the absorptive value of the earth itself, with a potential capacity for trapping and absorbing from a few to eight or more inches of rain, depending on soil type and cover, we can bring other factors into play. Contour cultivation is one of them. A few billion contour-plowed furrows will equal the water-holding capacity of many, many big reservoirs, and when water is thus held in the area

where it falls, it is easily and constructively controlled. Add to the simple contour plowing the water terraces that have greater capacity, that hold back runoff and put it into use in the soil or augment the ground water reservoirs. And, finally, the small retarding dam, many of them, at low cost, in headwater streams, can level off excessive flow, releasing only what the natural channel can carry.

Have there been proved results from this approach? There certainly have been. The Muskingum Project is one—a 20-yr record of functioning. More recently the West Owl Creek watershed in the Washita Basin of Oklahoma has been developed to secure insoak of several inches of precipitation through surface soil management. Small detention reservoirs were installed to trap the equivalent of 4 to 5 in. of runoff. And there are drawdown valves that permit release of such small impoundments in proportion to the ability of the natural channel below to carry it.

In the late spring of 1951, that watershed received at least 13 in. of precipitation in 36 hours, a flood-maker rain for sure. But the West Owl Creek Basin did not produce a flood. The stream ran moderately and relatively clear. The same storm pouring on untreated adjacent watersheds roared into flood, scoured off topsoil, and carried it down to the main Washita to produce devastating flood conditions above the big Texoma Dam and Reservoir.

The future that promises the greatest conservation, usefulness, and permanence in management of our water wealth, that promises enough good, usable water to meet ballooning demands, begins at the ridgepole between watersheds, from those between tiny

creeks to those between major basins. And it extends from there to a river's mouth, with every possible constructive use of that water wealth at every point along its line of transit.

#### Increasing Awareness

There are signs that we are aware of the water situation confronting us. Besides the ballyhoo and propaganda tub-thumping for the big-dam program of the Army Corps of Engineers and the Bureau of Reclamation, there have been significant publications on our water resources, the muddle we are in about them, and suggested lines of action to get us on sound footing in what may be done in the future. Several books dealing with water wealth have been published recently.

The task force report on natural resources, prepared by the group headed by former governor Leslie A. Miller of Wyoming, and the report of the Hoover Commission (at variance with that task force report) contain constructive material bearing on our water problems. When the President recently moved to accomplish one objective of those reports, and combine the Army Corps Engineers and the Bureau of Reclamation in the Department of Interior, the proposal was abandoned—abruptly, completely, and without much explanation.

The four-volume report of the President's Water Resources Policy Commission is a tremendous accumulation of wordage dealing with multiple aspects of water management. First, it is contradictory in many parts about existing situations and what should be done to secure inclusive water resource management. There is too much skirting around the problems and positive recommendations to solve them. Second, the emphasis is on the current

constructional approach as the main line to follow in water management and far short of what should be said about the protection and improvement of the machinery for delivering usable water—namely, the watersheds.

The report of the Engineers Joint Council is a far step toward clear appraisal of what must be done to arrive at sound water management, but it has a great deal of negative material, disagreeing with the President's commission, when perhaps the same wordage should be given to driving home the positive proposals in it for constructive action. Furthermore, inevitably, the balance of approach lies in the constructional field, which is entirely to be expected from those trained in engineering. I would not, by any possible means, try to suggest that we should drop the engineering phases and works in our water planning. Particularly there is drastic need for all of the forward-looking, sound-reasoning engineering thought exemplified in the Engineers Joint Council studies. Emphatically there is need for that.

What I would say to our clear-thinking engineers is that all their skills should be directed primarily to the contemplation of problems involved in protecting and perpetuating—improving also—the gigantic machinery of the water collection and delivery involved in our watersheds as such. When that part of the water production machinery is approached, the best engineering skills should be combined with those of the professions that are trained in soil management and the ground cover factor in watershed efficiency. With

that combination, you have a team that can do much to insure far better operation of the mechanisms, the natural facilities, for collection and delivery of water in its most usable and beneficial form and volume. You've got to insure the supply of the raw product before you can do things with it.

The goal of coordinated, inclusive management of the watershed unit certainly is what must come. Water management is a peoples' problem, and our water future depends on the people's accepting responsibility for solving these problems.

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## Meeting Flood Problems

**By J. P. Cookingham, Melvin P. Hatcher, Nathan S. Bubbis,  
Uel Stephens, Major C. Hagar, and Frank E. Willey**

*A panel discussion presented on May 5, 1952, at the Annual Conference, Kansas City, Mo., by L. P. Cookingham, City Mgr., Kansas City, Mo.; Melvin P. Hatcher, Director, Water Dept., Kansas City, Mo.; Nathan S. Bubbis, Gen. Mgr., Greater Winnipeg Water & San. Dist., Winnipeg, Man.; Uel Stephens, Director, Water Dept., Fort Worth, Tex.; Major C. Hagar, formerly Supt., Water Dept., Lawrence, Kan., at present City Mgr., Sterling, Kan.; and Frank E. Willey, Production Engr., Water Dept., Topeka, Kan.*

### Introduction—*L. P. Cookingham*

**A** DISASTER brought on by flood, tornado, earthquake, or enemy bombing poses problems that can be—that must be—successfully met if the services and protection expected by the people are to be performed adequately and completely. Many of the problems that may arise can be met by careful thinking and adequate planning before the disaster strikes. Thinking can be stimulated and planning kept current and complete if those having civic responsibility assemble occasionally and compare experiences. This panel is an attempt to do just that—to pool knowledge, some of it gained through bitter experience—so that it will be possible to plan more adequately to meet future disasters more successfully.

The two basic necessities of a disaster plan should always be borne in mind: knowing what to do and knowing how to do it. A course of action must be planned and personnel trained to carry it out. Without these essentials, no disaster plan can be effective and successful.

This panel will discuss five separate aspects of disaster planning for water utilities: establishing emergency authority, notifying the public, shutting off the plant, emergency water supplies, and restoring service.

### Organization

In establishing the emergency authority, the problem of organization must be given first consideration. Flexibility within the organization is essential. The need for an adequate number of assistants to the disaster chief should be considered. Also important is the provision of alternates for the disaster chief and his principle assistants, against the possibility that any one of them be unreachable or disabled by the disaster. The location of the disaster headquarters should be carefully considered. Adequate communication between the headquarters and the field forces is essential. The disaster plan is immediately dependent upon the organization and the communication system. Every conceivable possibility and probability must be con-

sidered to make sure that this aspect of the disaster plan will not fail. The best way to test the plan for effectiveness is to practice its operation under varying conditions. Weaknesses exposed in practice should be remedied through training and replanning.

The plan can succeed or fail depending upon the amount and type of information received by the public. Public anxiety is a component of disaster and must be recognized and met even though it may seem, when disaster strikes, that the time and energy necessary for a good public information program might better be spent in meeting the disaster more directly. A well informed public will not strangle disaster operations by curiosity, and information channels can be utilized to call for volunteer help when needed. When conservation of water, gas, or other utilities is necessary, the public must be told how to conserve.

Shutting off the plant is largely a matter of planning and practice. Every operation, every valve, necessary to shut down the plant should be familiar to the employees who may be called upon to perform this function. Here, again, practice and training are essential.

### **Emergency Water Supply**

Emergency water supply problems vary with each locality, the only general

aspect being the importance to each community. The 1951 flood in Kansas City curtailed water supplies 65 percent and threatened the entire system. The curtailed water supply was enough to emphasize the importance of adequate emergency supplies, and complete collapse of the system would have increased the problem a hundredfold. Adequate pure water is essential to the life of the community, and the protection of health is the essence of governmental service. Of equal importance is the distribution system, without which fire protection ceases and sanitation facilities are threatened, creating additional health hazards. In planning for this aspect of disaster, those responsible should become completely familiar with the facilities so that varying situations can be met as they arise. The type of equipment that is available from all sources for emergency distribution should be known at all times.

No matter how effective the fight against disaster, the total effort will be a failure if business, commerce, and industry are not rapidly restored. Restoration of service is the key to a successful disaster plan. Unfortunately, this is an aspect of disaster for which the least planning can be done. The ability and judgment of officials and the fighting spirit of the community will determine the success of this last aspect of disaster.

### **Establishing Emergency Authority—*Melvin P. Hatcher***

The mechanics of establishing authority needed at the time of a flood or other community disaster involve important legal and administrative considerations. Recovery operations will be expedited if the foundation for the plan and some of the main parts

of its framework can be thought out and put on paper before the emergency arises.

#### **Legislation**

Each community should have a complete disaster plan, the keystone of

which is the creation of an emergency organization. Legislation to enable the creation of an emergency organization varies with city charters and with state constitutions. The Kansas City, Mo., city charter vests considerable authority in the director of health; in his obligation to control disease, he is given "the power to take all steps and use all measures necessary to avoid, suppress, or mitigate such disease and relieve distress caused by flood or resulting from tornado, fire, or other disasters." Kansas City's first formal step to meet the 1951 flood crisis was a resolution by the City Council at a meeting not legalized by public notice that directed and authorized the city manager and the administrative staff "to take all steps and use all measures necessary to relieve the emergency of the hazards to health and safety caused thereby." At a later regular meeting, the council ratified its previous action with a resolution which related the relief actions to the authority of the director of health. Throughout all the recovery operations, however, the city manager was the chief administrative officer.

### Representation

At the time of the 1950 flood in Winnipeg, the City Council created an emergency committee with full powers "to take whatever steps were necessary for the protection of life and property and for the alleviation of distress." Most of the remaining personnel, originally five and later increased to eleven, were chosen from representatives of the health, safety, utility, engineering, and welfare activities in Winnipeg. In other words, it was a committee of specialists and technicians.

In its recovery plan after the flood in May 1949, Fort Worth, Tex. cre-

ated a separate department of the city which it called an Emergency Board. The board included thirteen members. The ordinance creating the board arranged for four members to be nominated by the mayor and confirmed by the city council, and it named the remaining members by position, including the city manager as the chief executive officer for the board, the mayor, the president of the Chamber of Commerce, a representative of the school district, the commanding officer of the State Guard, the Red Cross chairman, the county judge, and a representative of a contractor's organization—all representatives of the people or of interested organizations. The representation in the Fort Worth plan differed from that in the Winnipeg plan as the members of the Winnipeg Commission were primarily chosen for their acquaintance with the technical aspects of recovery operations. The Fort Worth plan was like the Winnipeg plan and unlike the Kansas City plan in that it included more than just the staff employees of the city.

### Coordination

The emergency authority plan should provide for coordination of effort between the central authority and other agencies having a part in the recovery operations. These agencies usually include the Red Cross and federal and civil defense agencies. Coordination with civil defense will depend on the extent of civil defense authority. The civil defense organization may be helpful in the mobilization of material, equipment, and manpower, and particularly in evacuation operations or in emergency water supply operations.

Kansas City's experience in the 1951 flood provides another idea for emer-

gency authority plans. In the first six days after the flood, the main recovery operations not involving city property were managed by Disaster Corps, Inc., a corporation comprising local contractors and labor organizations banded together for this particular purpose. Labor agreed to work at certain minimum rates and the contractors agreed to half-rate charges for equipment and to charge nothing for supervision. This organization made an outstanding contribution to Kansas City's recovery from the flood.

The need for such an organization should be anticipated. Approximately three days of strenuous effort were required to formulate incorporation plans and to procure proper insurance. Each emergency authority plan should provide the framework for this plan in advance of its need.

### Control Center

The essentials of a proper plan for disaster include preparations for a control center, communications, and public relations. A community's recovery from a disaster will be more orderly if matters relating to recovery can be channeled through an adequate, properly staffed control center. Plans for the center will vary with the size of the community and character and extent of the disaster, but the need for the center should be anticipated in a number of ways. The telephone arrangements should permit the answering of all calls promptly. The space requirements should provide close contact between top-level personnel and provision should be made for the radio and news reporters.

In the 1951 flood, Kansas City set up its control center around the office of the director of public works. The city

manager, as chief executive officer, and the other directors most involved in the recovery operations had desk space on the same floor as the director of public works. This control center was manned around the clock for approximately six days after the flood. All news releases and orders were issued from this emergency headquarters.

### Communications

Communications are, of course, essential in any emergency. When the 1951 flood struck, the Kansas City Water Dept. missed by approximately one month, having a fleet of cars equipped with two-way FM radio. There were times when the emergency flood headquarters was handicapped considerably by the lack of communications with the crew that undertook the rehabilitation of the Turkey Creek Pumping Station. Certain operations were helped immeasurably by radio-equipped cars that were later made available for the recovery work.

### Public Relations

Good public relations work in any emergency situation will include complete and prompt news releases and general orders. These releases and orders should require a minimum amount of explanation and interpretation. Kansas City issued more than 100 news releases and general orders in the two weeks following the flood. This work was supervised around the clock by two particularly well qualified staff members who were assisted by a staff of approximately twelve young men who at that time were serving an internship in public administration work with the city.

Finally a disaster plan should include such relief as can be provided for the

supervisory forces. All of the regular employees of a water department are required to work to the point of total exhaustion in an emergency such as that experienced in Kansas City in 1951. One supervisory employee was required to work 60 hr without relief in this period. Relief for the lower

echelons of workmen is usually readily available. Kansas City relied on three consulting engineering firms during its flood difficulty and found their services helpful. It is likely that these services could have been more helpful if they had been planned for in advance of their need.

### Notifying the Public—*Nathan S. Bubbis*

Public information on the water supply of a community is important at all times, but much more so during an emergency, whether the emergency strikes the community suddenly or following a period of warning. Except for flash floods, there is usually a period of expectation before a flood strikes. For several reasons, it is essential that people be kept informed at all stages of the crisis:

1. To relieve anxiety and prevent panic.
2. To inform the people of what steps to take to protect themselves and their property.
3. To secure cooperation in carrying on protective measures for the city as a whole.

It is understandable that during any emergency, the people affected become most concerned about their safety and the protection of their families and homes. Unless proper steps are taken, this concern can continue to mount and finally result in panic. It is therefore most important that the people be kept informed continually and given up-to-the-minute information. All public statements should be issued by the proper flood authority. These statements should be concise and clear-cut, and should be presented in a manner capable of allaying as much anxiety as

possible. It is important to guard against the ever-present tendency of news agencies to sensationalize existing conditions. Great harm can be done by spreading and exaggerating rumors.

#### Advance Information

Wherever possible, instructions on what steps the individual citizen can take to protect his property and safeguard his health should be issued well in advance of the actual emergency. Such instructions should include the storing of a minimum supply of water for cooking and drinking in the event that normal plant facilities are cut off. Information about the condition of the water supply should be given the public. If it is safe, specific assurance should be given and the further assurance that the public will be kept informed of any change. As soon as there is a question of contamination, the health authorities should warn the public and issue specific instructions to boil the water or specify other methods of sterilization. Sirens or other warning devices should be used to announce the imminence of an extreme emergency, such as the breaking of a dike.

#### Cooperation

During any emergency, every effort is made to save the community from be-

ing inundated, by the erection of dikes and levees, by sandbagging, and by pumping sewers. This effort means a continuous, round-the-clock battle, usually calling for all resources of material and manpower. The regular municipal employees must be reenforced. It has been found from practical experience that, if a well organized, efficient flood control authority is established with a well directed plan of action, the community will respond. If properly informed, they will cooperate wholeheartedly.

### **Communications Survey**

The emergency authority, as one of its first steps, should make a complete survey of all means of communication, including press, telephones, television, and public and private radio systems. These facilities should be used as completely as possible. Provision should be made to establish links between various utility radio systems, such as fire, police, and water works systems.

### **Press Liaison**

During the 1950 flood in Winnipeg, a member of the press was placed on the Flood Control Committee and was charged with the responsibility of acting as press liaison officer. All reporters were requested to clear their press releases with the press liaison officer before publishing, and although such clearance was voluntary, the response was wholehearted. Radio stations remained on the air around the clock and, with the press, cooperated in releasing all information and instructions that the Flood Control Committee required to be transmitted to the public.

### **Telephone Inquiries**

To handle incoming telephone inquiries from the public, a special switchboard having numerous additional lines

was set up in the city engineer's office. This information desk was staffed around the clock by employees, usually from the clerical and design staff of the department, under the supervision of one of the engineers. Any person desiring information of any kind could call, ask for the information, and receive an answer. Although definite answers to specific questions were not always possible, the general effect on morale was most beneficial. The very fact that an individual could place a call, state his question, and receive a calm reply created a feeling of reassurance. The people knew that an effective organization was still looking after their interests.

### **Power Supply**

It should be realized that most of the normal communication systems rely on power for their operation. All radio stations and telephone exchanges should be provided with independent auxiliary power supplies so that any failure of the regular power system will not put them out of business. If the power supply fails, however, the individual receiving sets, except for battery models, will, of course, be out of service. When the individual receiving sets cannot be used, it is necessary to use sound trucks to convey the information.

### **Radio**

Fighting a flood is similar to and must be dealt with on the same basis as a military operation. Usually the battle extends over a wide front, and supplies of both material and manpower are spread very thin. The necessity for an adequate system of communication cannot be exaggerated. It is essential that the people in direct control know at all times what the situation is anywhere. It is necessary for people in

the field to make their requirements and their particular situation known immediately, so that they may receive the necessary help.

Under the abnormal conditions which prevail, the normal system of line communication cannot be relied upon, and, from experience in both the Winnipeg and Kansas City floods, it is felt that the only satisfactory reliable system is that of radio communication. Before the flood in Winnipeg, a number of the utilities, including the water utility and the engineering department, set up systems of two-way FM radio communication. Radio had proved its usefulness during normal operations and also during the flood of 1948. The number of radio-equipped vehicles was increased, however, the moment it was evident another flood was imminent. This action proved of inestimable value. The communication system turned out to be one of the most important factors in fighting the flood, contributing greatly to the efficiency with which operations were carried out.

### Shutting Down the Plant—*Uel Stephens*

As this paper is being written (April 15, 1952), many water works superintendents along the Missouri River Valley are doing the very thing which it discusses—"Shutting Down the Plant."

Generally speaking, as a result of some serious condition in the community, proper authority declares a state of emergency to exist and the people are notified. A common type of disaster is that caused by excessive rainfall, overflowing rivers, and flooding out of the water plant which is solely dependent upon electric power from a private utility which, it may be assumed, will not be put out of service.

The warning to the people should contain statements about the flooding

### Summary

Although each emergency will create its own problems requiring solutions that will depend on local conditions, the following general observations can be made:

1. It is essential to keep the public informed at all times in order to relieve anxiety and obtain help and cooperation.
2. Wherever possible, a system of radio communication for the water utility should be established. Such a system is justified from the point of view of normal operations and is vitally essential during an emergency.
3. A survey of all available means of communication and a plan of coordinating these means should be made well in advance of the actual emergency.
4. An adequate system of press and radio relations should be established so that their cooperation and assistance can be obtained.

of the entire water treatment and pumping plants, which means that for several days the public water supply will be out of operation. The people should take every precaution to store water while it is still available in every obtainable container and to be especially careful about fire, as the water lines will soon be drained. Boiling of water will be necessary, and water from questionable sources should be used only in accordance with instructions issued by proper health authorities.

### Electric-Powered Plant

As the floodwaters reach the elevation at which the water plant's protection levees will be topped or a break

in them becomes imminent, the plant operator, should, on the basis of previous training, begin to prepare the plant for the shutdown. In an all electric-powered plant, at which the electric motors are subject to flooding, the first step is the notification of the power company that, at a specific time, the entire plant will be shut down. Orders should be given to cut off the power at the power station a few minutes after the shutdown time.

After emergency, portable, standby lighting equipment has been put in service, all switches controlling incoming electric power should be opened and tests should be made after the power is turned off at the power plant to make certain no electric current will reach the water plant after flooding begins. The time interval between the shutting off of electric power and the actual flooding will probably be only a few minutes, but during this short time all detachable equipment which has not already been moved should be removed and placed above the reach of high water.

Other precautions, such as removing gasoline, oil, and other flammable materials that have been stored below the level of high water, should be taken. Oil or gasoline spreading over the water surface creates a fire hazard and covers the equipment with an oil coating as the water falls, making it much more difficult to clean when the floodwaters have subsided.

### **Steam-Powered Plant**

In a steam-powered plant, many of the same steps followed in shutting off electric power are applicable. If possible, the fires should be extinguished far enough in advance of the actual flooding of the boiler room to permit the firebox lining to cool and thereby

reduce the fracture damage to firebrick when it is suddenly subjected to cold water. The supply of boiler fuel should be turned off at its source or at least outside the plant area to reduce the fire hazard.

At the same time that the pumping plant is being put out of service, other parts of the water plant, such as filters, chemical treatment and chlorination facilities, and mechanical mixing equipment should be taken out of service. Essentially the same procedure as that outlined for shutting off the pumping plant should be followed. All electric switches should be opened, the power cut off at its source, and, of course, whenever possible all readily removable items of equipment and supply should be secured out of danger. If the chlorine drums in use are subject to overflow, the attachments should be removed and the drums securely closed to prevent the possible escape of chlorine if the connecting tubes are severed. Nearly empty drums should be lashed down to keep them from floating away. Chemicals such as lime and alum are usually stored on the second floor and are, thus, frequently out of danger from flooding.

### **Guards**

When it becomes evident that the plant must be shut down, proper security measures must be taken. The disaster headquarters should be requested to furnish proper guards, armed and having police power, to be stationed along the important routes and posts in order to patrol the property to prevent vandalism. A system of passes should be initiated by the proper disaster authority and only authorized persons should be permitted to enter or leave the plant area. It is espe-

cially necessary to have guards equipped with motorboats to patrol the flooded area.

As early as possible the staff should be organized into crews, and each crew should be divided into shifts and assigned specific tasks. Crews not on duty should go home and rest as much as possible. Food can be supplied to the workers through the Red Cross and Salvation Army.

The emergency organization can and should be perfected on paper long before an emergency occurs. Through a series of practice problems much valuable experience can be gained. In the distribution system, where line breaks may occur, valves should be closed to prevent the waste of water that may be badly needed before operation can be restored. All plant records should be removed and preserved, as they provide much assistance in the restoration of service.

#### General Rules

There may be emergencies other than flooding that could cause a quick shutdown of the water plant. The following general rules should be observed in any emergency shutdown:

1. Remove all movable equipment and supplies from the danger area.

#### Emergency Water Supply—*Major C. Hagar*

It is too late to search for emergency water supplies after the water plant has been put out of commission. The cause of the catastrophe does not matter. When the plant goes down it immediately becomes necessary to make provision for emergency water supplies to maintain health and sanitation until the system can be restored to normal.

2. Make available and ready for use all emergency equipment, such as light plants, pumping equipment, gas masks, and automatic and power equipment.

3. Prevent employees or volunteer help from taking unnecessary risks.

4. Enlist the aid of the police and troops to prevent the public from causing undue interference and from going into restricted areas.

5. Disconnect all electric power at both the water plant and power plant.

6. Initiate plans immediately for the rehabilitation of the plant, to put it back in service as soon as possible.

7. As a precaution and before the occurrence of any emergency, stockpile surplus supplies and equipment in locations that are above high water but where they will be readily available for use.

8. A further precaution would, of course, be the location of the entire plant on high ground above any possible flood stage.

9. Insofar as possible, store duplicate "as built" plans of the plant in a safe place away from the plant.

10. Adopt a system of emergency practice problems to insure that all employees will be familiar with the specific assignment they are to perform when the emergency arises.

#### Advance Planning

Planning in advance is absolutely essential for putting emergency supplies in operation in the shortest possible time. Such planning should be as complete as possible and should be reappraised from time to time to see that it is the best and most up-to-date way to approach the problem.

Planning should consist of two phases: [1] establishing the broad overall program, including the location of the emergency supplies, the manner of their use, the probable yield, and the life of the supply; and [2] determining the detail of connections to the system, treatment and pumping facilities, and, if it is necessary to haul the water by tank and distribute it in cans, the provision of tanks, containers, chlorine, and personnel for hauling and serving the water at watering stations.

As a result of such planning during the Kansas River flood of July 1951, Lawrence, Kan., was able to maintain normal service to the community even though the raw water pumping system was out of service for five days. Plans for such an emergency were made in 1946. It was necessary at that time to purchase dredging equipment to combat a low water condition at the intake. It was felt that although low water problems were paramount then, that sometime a high water condition might be as bad or even worse.

### Dredging Equipment

The 6-in. dredge pump and the 4-in. jet pump purchased are self-contained and portable. The dredge pontoons were built so that the water department's crane could handle them. The motor towboat was a size that could also be handled by the crane. Enough light-weight pipe was purchased to enable the department to pipe water or sludge anywhere in the water plant area. This equipment could be used either for dredging or for pumping raw water to the filter plant.

In addition to this equipment, enough 8-in. asbestos-cement pipe has always been on hand to run temporary lines anywhere in the water plant area. By experimenting, it was found that

the asbestos-cement pipe could be held together by stringing a cable from end to end of the pipeline, tying the cable at one end and taking up slack at the other end with a coupling puller. To make the cable follow the curves of the pipeline it is necessary to wire the cable to each coupling. Mechanical-joint, cast-iron pipe could be laid just as easily. Such temporary pipelines are laid on top of the ground.

If sufficient equipment of this kind is at hand and if the water treatment plant is above the flood plain, service on an emergency basis can be maintained for an indefinite time. If uninterrupted service is to be given, however, sufficient time must be allowed before the regular pumping facilities are discontinued to install the emergency equipment and prepare it for operation.

Communities in which the entire water plant facilities are within the flood plain face a more difficult problem. Advance planning is of great benefit when the plant goes down, however. Under such conditions, of course, water for drinking comes first. Those charged with the prevention and control of fire sometimes think their needs should be first. In the author's opinion, elevated potable water storage should be arranged so that it can be cut off the line immediately. Such storage is generally of large enough capacity to last for several days as drinking water. Tank trucks could be used to distribute it in a planned manner. A railroad elevated water storage tank was used in the flooded section of North Lawrence.

### Chlorinated Raw Water

The distribution system should be so arranged that emergency pumps can be connected and, from emergency water sources, supply the needed fire

and sanitary toilet protection. Chlorine and chlorination equipment should be removed from the plant before it is flooded so that heavy chlorination may be applied to the water at the emergency pump locations. By notifying the public not to use the tap water until it is boiled and, at the same time, telling them where safe water may be obtained, excellent cooperation is usually obtained. The author found during the 1951 flood that if the community is told exactly what the problem is and how it is being resolved, everyone will cooperate.

The author's suggestion for pumping heavily chlorinated raw water into the mains for fire protection and sanitary use may not meet with the public health authorities' approval, but, after

observing the action and results of heavy chlorination of mains that contained raw water after the 1951 flood, he feels that if the water is boiled for several days after clean water is reintroduced into the mains, there will be no detrimental effects. It is necessary to have an extended program of main flushing to remove all silt that might be deposited from the raw water, and mains must be sampled extensively to determine the bacteriological conditions of the water.

Every type of disaster requires special treatment, but a carefully thought out and planned disaster program is the best answer to trouble when it comes. A fireman and policeman trains for emergencies every day, and so should a water works man.

### Restoring Service—*Frank E. Willey*

The author has had two sad experiences of restoring service in pump pits in which horizontal motor-driven centrifugal pumps were installed. One pump pit was flooded when floodwater infiltrated through the ground and then through an opening that the contractor boxed out under a concrete pump base to admit the suction pipe to the pump. As the opening was not visible, it was not found until after floodwater began pouring into the pump pit. It was impossible to get to this opening to stop the flow of water and consequently the pit filled to a depth that was sufficient to submerge the electric and gasoline motors. The electric motors had to be cleaned and dried with heat. Precautions should be taken in the design and construction of every pit and structure that might be subjected to outside hydrostatic water pressure to ensure that the structure is strong enough to withstand this pressure. No openings should be built into the structure that

will permit water to enter. Wall sleeves for pipe connections are very desirable.

The low-service pumping station at Topeka, Kan., was flooded when a horizontal check valve slammed shut after a pump had stopped, thus causing water hammer in the discharge line. This water hammer ruptured a valve bonnet, letting water back into the pump pit from the settling basin. Although the water was quickly pumped out, it was necessary to clean and dry out all the electric motors. The pumps are now equipped with spring-loaded quiet closing check valves that will prevent the recurrence of such an accident. This incident illustrates one way in which a pump pit can be flooded without floodwater going over the top. All installations should be studied and the hazards eliminated. Power failure will stop pumps immediately, thus not permitting time to operate manually controlled equipment such as gate valves. All openings in the building structure

should be eliminated. The author feels that deep pump pits are not advisable.

### Operation Water Works

During the July 1951 flood on the Kansas River the filtration and pumping plant was saved from the highest floodwater experienced at Topeka, Kan., by a Herculean operation directed by water department personnel and assisted by the Army Corps of Engineers, professional engineers, all branches of the Army, Navy, and Coast Guard, contractors, Red Cross, and thousands of civilians. "Operation Water Works" was carried on for four days continuously around the clock, every man on the job working as he had never worked before. The water works grounds are protected from floodwater by a combination concrete flood wall and an earthen dike. The flood protection was built in 1938 to an elevation 4 ft above the 1903 flood crest, the yardstick for floods before 1951. The water crested 22 in. below the top of the flood wall, thus topping the earthen dike by a few inches. To keep the floodwater from overflowing the dike, thousands of sand bags were placed on the dike. Ground water rose to the surface of the ground, making it necessary to pump all waste water from the Filtration and Pumping Plant. Some vitrified clay and concrete sewers failed, thus adding to the problem of dewatering the plant buildings. Ground water also poured into the high-service pumping plant basement and threatened to put the high-service pumps out of service. The high-service pumps were saved, however, by the installation of many portable pumps which dewatered the basement. Using three portable pumps, all the waste water had to be pumped over the dike from a central receiving well built into the outfall sewer.

The floor in the clear water reservoir, an underground structure, was cracked in several places when the water level was pumped too low by an extra heavy draft on the system when the hydrostatic pressure on the outside was high as a result of the floodwaters. This reservoir floor was later repaired by building bulkheads to permit the dewatering of the sections that needed repairing. The floor was repaired without taking the reservoir out of service except to build and remove the bulkheads.

In the rehabilitation of electric equipment, the service departments of the major equipment companies should be consulted as soon as possible, as these companies frequently have within their organization employees and officials who have had experience in similar situations. General contractors and their staffs and construction equipment are helpful and should be fully utilized.

### Finances

One important feature to remember from the very beginning of the emergency is the fact that emergency work costs money and expenditures of large sums may be involved. At the time it officially proclaims the existence of an emergency, the governing body should make appropriations of funds. The official responsible for handling various aspects of the emergency work should, at the outset, establish some simple form of bookkeeping so that when bills begin to come in, there will be some reason and authority for making payments.

### Essential Services

Kansas City's first general order was released within four hours after the partial failure of the water supply. It stated: "All offices and business establishments, except those which are es-

•sential to health and food services, are requested to discontinue operations as a means of conserving water and to remain closed until a better knowledge of the situation is developed. Exceptions to this order are restaurants, drug stores, essential food stores, hotels, newspapers, radio stations, medical offices and services, public utilities, and others of this nature. All residents of Kansas City, except those engaged in essential operations, are requested to go home and remain there in order to reduce traffic congestion which is hampering the emergency operations." From this general curtailment order, service was gradually restored to the different classes of customers as pumping equipment was rehabilitated and placed in service.

### Sanitary Aspects

The sanitary aspect of restoring service cannot be overlooked. The restoration of service in a water treating and purification plant that has been flooded should be given careful consideration. It is of the utmost importance that all water produced be pure and healthful from a bacteriological standpoint. All floodwater and silt must be removed from the finished water reservoir. This reservoir should then be disinfected with a strong chlorine solution (approximately 300 ppm), the side walls and floor scrubbed down, and all water used for scrubbing removed. Sand filters should be thoroughly washed and sterilized by treating the filter beds with a strong chlorine solution. When basins, filters, and clear water reservoirs have been thoroughly cleaned and placed in operation, chlorine residuals of 2 to 3 ppm should be maintained until bacteriological tests show that they are no longer necessary.

### Distribution System

A flooded distribution system should not be polluted if the pressure has not been off in the system. During the time North Topeka was completely submerged, the pressure in the distribution system was always positive, although much lower than normal as a result of the large quantities of water that were wasted through the broken service lines of houses that had been washed from their foundations. As soon as floodwaters receded, samples were collected daily in this area and not a single sample showed any pollution. No mains were broken by the floodwater in the flooded area. If mains are broken and have to be shut down for repairs, that section of pipe should be thoroughly sterilized with strong chlorine solution before service is restored.

The state board of health has sanitary engineers that are always ready to assist in any emergency that may arise and can give unlimited assistance. These men know how to handle sanitary problems in wells, treating plants, and distribution systems. They also know of the availability of portable chlorination and filter equipment.

### Summary

1. Make a survey of the possible disasters that may happen to the water supply, such as flood, explosions, wind storms, and even bombing.
2. Develop a plan for restoring service in the event such a catastrophe does strike.
3. In accordance with this plan, procure a minimum amount of materials and store them in a safe place removed from the hazards that might cause a disaster. These precautions will facilitate the restoration of service.

# Removal of Radioactive Material From Water by Slurrying With Powdered Metal

By William J. Lacy

*A contribution to the Journal by William J. Lacy, Chemist, San. Eng. Branch, Engineer Research and Development Lab., Fort Belvoir, Va.*

IN the event of an atomic bombing, radioactive contamination of water could arise from four possible sources: [1] fission products of the bomb; [2] induced activity in the dissolved mineral matter in the water; [3] unfissioned material of which the bomb was made ( $U^{235}$  or  $Pu^{239}$ ); and [4] contaminated soil blown or washed into the water supply. The dissolved or suspended radioactive material in water could be a source of alpha, beta, and gamma radiation, and ingestion could cause physiological damage. When radioactive materials are deposited in the body, the effects depend upon several factors (1) including: [1] site of deposition; [2] physical half life; [3] biological half life; [4] type of deposition—local or entire body; [5] type of radiation; and [6] energy. The changes that are produced may not appear until the dangerous material has resided in the body for many years and irreparable physical damage has been done (2).

## Permissible Concentrations

The International Commission on Radiological Protection has set up maximum permissible concentration values for radioisotopes in air and water. The maximum permissible concentration values for water for emergency drinking purposes given in Table

1 have been proposed by William F. Bale (3).

## A New Method

The U.S. Atomic Energy Commission has placed contracts with many universities and research laboratories to study the problem of decontamination of radioactive water. The methods in use at present include ion exchange, distillation, coagulation, and adsorp-

TABLE 1  
*Proposed Emergency Levels for Beta-Gamma Activity in Drinking Water\**

Length of Time Water Is Consumed	Safe $\mu c$ per ml	Low, Acceptable Risk $\mu c$ per ml
10 days	$3.5 \times 10^{-3}$	$9 \times 10^{-2}$
1 month	$1.1 \times 10^{-3}$	$3 \times 10^{-3}$

\* For period immediately following atomic explosion.

tion (4-7). Lauderdale and Emmons (4), while investigating adsorptive methods, found that steel wool is capable of removing very substantial quantities of radioactivity from water. This observation led to the suggestion by Don C. Lindsten of the Engineer Research and Development Laboratories that the removal of radioactivity from water by slurring with powdered metals be investigated. This paper gives the results of the investigation.

### Test Procedure

Oak Ridge tap water was used in all the tests, and the following radioactive materials were used as contaminants: Ru<sup>106</sup>-Rh<sup>106</sup>, Y<sup>91</sup>, P<sup>32</sup>, Cs<sup>137</sup>, Zr<sup>95</sup>-Nb<sup>95</sup>, Ce<sup>141-144</sup>, Pr<sup>144</sup>, I<sup>131</sup>, Ba<sup>140</sup>-La<sup>140</sup>, and mixed fission products known as MFP-1 and MFP-2. MFP-1 is a mixed fission product contaminant consisting of 44 per cent trivalent rare earth, 27 per cent cerium, 17 per cent strontium,

nants were obtained from the Operations Div. of the Oak Ridge National Laboratory (8).

The powdered metals evaluated included iron, aluminum, copper, and zinc. The same experimental procedure was used for the evaluation of each powdered metal. A stock solution was made by dissolving the radioisotope being used in tap water having a pH of 8.0. Initial samples of the

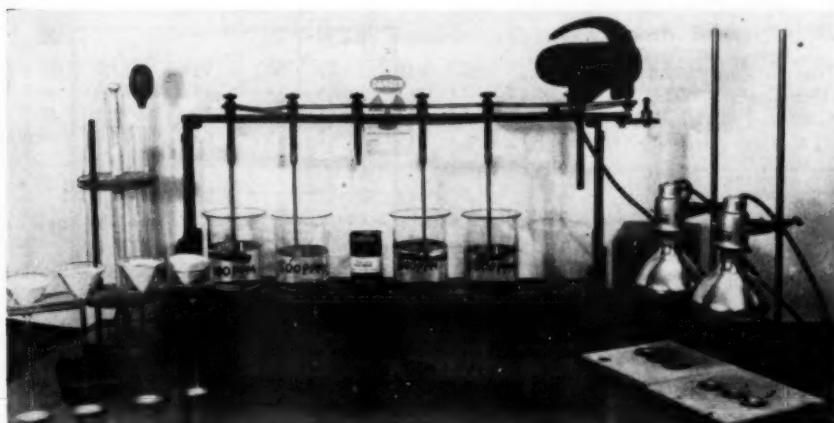


Fig. 1. Laboratory Equipment Used in Removing Radioactive Material With Powdered Metal

Stock solution is added to each of four beakers containing metal dust in concentrations of 100, 500, 1,000, and 2,000 ppm. The slurry is stirred at a constant speed of approximately 250 rpm for 90 min. Samples are taken from each beaker every 15 min, filtered into counting dishes, dried with the infrared lamp, and counted.

5 per cent barium, 3 per cent ruthenium, 1 per cent cesium, and 3 per cent traces of a large number of other radioisotopes. MFP-2 is a mixed fission product contaminant consisting of 50 per cent cesium, 16 per cent ruthenium, 10 per cent trivalent rare earths, 10 per cent strontium, 5 per cent cerium, 5 per cent barium, and 4 per cent traces of a large number of other radioisotopes. All of the radioactive contami-

stock solution were placed in a stainless-steel counting dish, dried under infrared lamps, and counted with a Geiger-Muller mica end-window tube (2.5 mg per sq cm thick). Then 500 ml of the stock solution was added to each of four beakers containing quantities of the metal dust under test to give concentrations of 100, 500, 1,000, and 2,000 ppm (Fig. 1). The slurry was stirred at a constant speed of approxi-

TABLE 2

Removal of Radioactivity from Contaminated Water by Slurrying with Powdered Metal

Metal	Removal of Contaminant per cent									
	Ru <sup>106</sup> -Rh <sup>106</sup>	Y <sup>91</sup>	P <sup>32</sup>	Cs <sup>137</sup>	Zr <sup>90</sup> -Nb <sup>95</sup>	Ce <sup>141</sup> - <sup>148</sup> Pr <sup>144</sup>	I <sup>131</sup>	Ba <sup>140</sup> -La <sup>140</sup>	MFP-1	MFP-2
<i>500 ppm for 30 min</i>										
Iron	96.6	—	68.9	10.1	92.6	99.6	10.0	83.9	78.8	34.2
Aluminum	88.4	—	81.8	—	99.7	99.1	12.7	62.2	87.1	7.3
Copper	79.4	—	—	—	90.9	98.0	19.4	68.4	90.0	27.4
Zinc	91.9	94.7	90.0	—	89.5	98.7	17.3	58.0	64.7	36.4
<i>1,000 ppm for 90 min</i>										
Iron	99.6	—	98.1	10.0	99.0	99.9	38.1	94.8	85.8	52.5
Aluminum	92.8	—	84.2	—	99.8	99.8	23.2	73.8	89.4	8.2
Copper	93.7	—	—	—	97.4	99.5	42.2	74.5	92.1	49.3
Zinc	98.4	97.8	98.1	—	96.9	99.9	45.7	65.7	76.6	39.6

TABLE 3

Removal of MFP-1 and P<sup>32</sup> from Water by Slurrying with Powdered Metal

Contaminant	Metal	Dose ppm	Activity*—counts per min per ml—at Different Slurrying Times—min				
			0	15	30	60	90
MFP-1	Iron	100	4,915	1,455 (70.4)	1,375 (72.0)	1,260 (74.4)	1,223 (75.1)
		500	4,940	1,209 (75.5)	1,050 (78.8)	875 (82.3)	852 (82.4)
		1,000	5,059	1,260 (65.2)	1,888 (74.5)	972 (80.8)	718 (85.8)
		2,000	4,982	1,259 (74.7)	1,031 (79.6)	687 (86.2)	521 (89.5)
MFP-1	Zinc	100	10,161	4,880 (52.0)	4,638 (54.3)	4,652 (54.2)	4,621 (54.5)
		500	10,203	3,853 (62.6)	3,635 (64.7)	3,273 (68.2)	3,125 (69.7)
		1,000	10,360	3,333 (67.8)	2,610 (74.8)	2,459 (76.3)	2,420 (76.6)
		2,000	10,244	2,700 (73.6)	2,294 (77.6)	2,117 (79.3)	2,500 (80.0)
P <sup>32</sup>	Iron	100	11,845	5,714 (51.4)	3,794 (66.8)	3,152 (73.1)	2,173 (81.3)
		500	12,102	4,609 (53.2)	3,718 (68.9)	1,735 (85.4)	263 (97.6)
		1,000	11,801	3,367 (71.3)	1,746 (85.0)	828 (92.7)	191 (98.1)
		2,000	11,788	821 (92.8)	222 (97.9)	86 (99.0)	30 (99.5)
P <sup>32</sup>	Aluminum	100	1,343	243 (81.9)	180 (86.6)	200 (85.1)	218 (83.8)
		500	1,447	288 (80.1)	263 (81.8)	242 (82.6)	264 (81.8)
		1,000	1,341	213 (84.1)	176 (86.9)	190 (85.8)	212 (84.2)
		2,000	1,392	204 (85.3)	200 (85.6)	220 (84.2)	223 (84.0)
P <sup>32</sup>	Zinc	100	6,613	1,701 (74.3)	1,085 (84.4)	533 (91.9)	376 (94.3)
		500	6,580	1,366 (79.2)	661 (90.0)	244 (96.3)	169 (97.4)
		1,000	6,333	1,043 (83.5)	445 (93.0)	175 (97.2)	120 (98.1)
		2,000	6,590	973 (85.2)	312 (95.3)	74 (98.9)	66 (99.0)

\* The removal of the radioactive contamination is expressed as a percentage and is shown in parentheses. The data for activity in counts per min per ml were not corrected for the geometry of the instrument.

mately 250 rpm for 90 min. Samples were taken from each beaker every 15 min, filtered, placed in a counting dish, dried, and counted. By this procedure, it was possible to evaluate the efficiency of each metal dust at variable dosages and for different contact times.

### Results

The data given in Table 2 show that powdered metal was very effective in removing most radioactive contami-

room temperature tended to form small amounts of floc which also helped remove the radioactive contamination. The data in Table 2 were condensed from detailed experimental data. The detailed data for the runs using two of the more important contaminants, MFP-1 and  $P^{32}$ , are given in Table 3.

The data for the removal of  $P^{32}$  with powdered iron shown in Fig. 2 indicate that increased dosages gave appreciably higher removal percentages. Increased removal with increased dosage did not result with all radioisotope contaminants, however—for example,  $Zr^{95}$ — $Nb^{95}$  and  $Ce^{141-144}$ — $Pr^{144}$  were removed almost as efficiently with 100 as with 2,000 ppm powdered iron.

### Discussion

The process of removing radioactive material from contaminated water with powdered metal appears to be a surface phenomenon. The results may be explained as adsorption of radioactive materials on the surface of macroscopic metallic particles. The rate of adsorption is very rapid at first but falls off quickly with time. Also, the addition of increased amounts of powdered metal usually does not increase the removal proportionally. These facts all indicate that the underlying mechanism is adsorption. It is believed that water contaminated with radioactive materials from an atomic bombing can be brought to safe tolerance level for emergency drinking purposes by a preliminary slurring with powdered metal, followed by conventional coagulation and filtration, provided the initial beta-gamma activity is not greater than  $10^{-2} \mu\text{c}$  per ml.

### Acknowledgment

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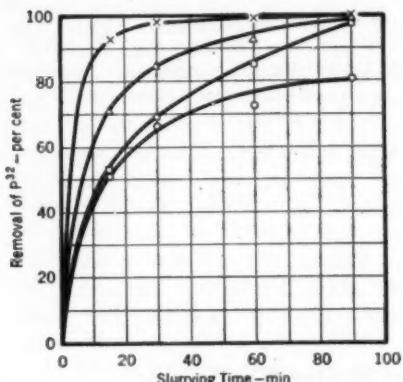


Fig. 2. Removal of  $P^{32}$  With Powdered Iron

Increased dosages gave higher removal of  $P^{32}$

—×—2,000 ppm powdered iron  
—△—1,000 ppm powdered iron  
—□—500 ppm powdered iron  
—○—100 ppm powdered iron

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In general, of the metals tried, powdered iron appeared to give the best results. The iron in water at

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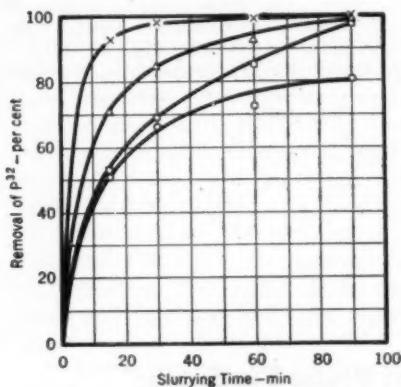


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the Oak Ridge National Laboratory for their cooperation and for the many helpful suggestions they made throughout the study.

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## The Place of the Manufacturer in the Water Works Industry

By William J. Orchard

*A paper presented on May 5, 1952, at the Annual Conference, Kansas City, Mo., by William J. Orchard, General Mgr., Wallace & Tiernan Co., Inc., Newark, N.J.*

CERTAINLY if the 24 men—20 water works engineers, and 4 manufacturers—who met on March 29, 1881, in Engineers Hall at Washington University, St. Louis, and organized the American Water Works Assn. could see the solid, substantial organization of today, with its more than 9,000 members, fine monthly JOURNAL, 30 active sections, three strong divisions and a fourth in the making, and 53 committees that really work, they would feel that they had built a good foundation.

As four of the original founders were manufacturers, it is reasonable to assume that all 24 of them would be happy, too, if they could learn of the fellowship that exists within a manufacturers' association of nearly two hundred members. And, of a certainty, they would be astounded if they could have witnessed the 1952 annual gathering at Kansas City in its five full days of earnest activities, taxing the facilities of the Municipal Auditorium, with a registration of 2,000, technical programs taking four and a half days, exhibits of water works equipment covering 20,000 sq ft, and a carefully planned program of entertainment after each day's job was done.

If these founders could look back over the past 71 years in an effort to account for these solid accomplish-

ments, they would find three basic reasons standing out: [1] a marked growth in public water supplies and in water treatment plants; [2] a water works association that through the years has continuously increased and improved its service to its members; and [3] the fellowship and cooperation, without a counterpart, that has existed between the Association and an organized group of manufacturers whose constitution sets forth as an objective "the advancement of the interest of the American Water Works Association and the establishment of friendly cooperation and relationships."

### Growth of the Industry

On March 29, 1881, there were less than 1,000 public water supplies and very, very few and very modest water treatment plants. Today there are approximately 15,500 water works serving more than 95,000,000 people, and 4,750 water treatment plants to insure that they get pure water. March 1881 was twelve years before Hiram F. Mills put his slow sand filter plant into operation at Lawrence, Mass., and 21 years before the first rectangular rapid sand, or American type, filter was placed in service at Little Falls, N.J.

At the turn of the century there was a great controversy over the use of alum and soda ash and lime in water

the Oak Ridge National Laboratory for their cooperation and for the many helpful suggestions they made throughout the study.

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treatment. Chlorination, worked out by Leal, Johnson, Jennings, and others, was first introduced in a public water supply in 1908 at Boonton, N.J., for the water supply of Jersey City. Flocculation equipment, clarifiers, water meters, feeders, chlorinating equipment, and chemical appliances were for the most part not more than gleams in the eyes of their inventors. As the need for public water supplies and pure water came to be recognized, the American Water Works Assn. gradually grew in response to a need for competent leadership.

### Growth of the Association

In 1890 when the Association was nine years old, it had 400 members. Twenty years later in 1910 there were 1,000 members. At this point the annual meetings were divided into separate discussion groups on specialized subjects. The Chemical and Bacteriological, now the Water Purification, Div. was organized in 1910. By 1913 geographical sections or regional meetings were proposed. In 1914 the New York-New Jersey Section became the first of what are now 30 geographical sections of the Association. In 1914 the JOURNAL was first published quarterly, as a supplement to the Association's *Proceedings*. It was expanded to a bimonthly publication in 1920. In 1924, when the Association had 2,000 members, the JOURNAL became a monthly under the editorship of John M. Goodell and, later, of Abel Wolman.

In 1920 the Council on Standardization was established and in 1925 it completed and published the *Manual of Water Works Practice*. In 1928 the council became designated as the Water Works Practice Committee, the name by which it has been known under the successive and able chairman-

ships of but two men—Malcolm Pirnie and Louis Howson.

Under the part-time secretaryships of John M. Diven and Beekman C. Little and the dynamic influence of Presidents George W. Fuller, Harry E. Jordan, Frank Barbour, and others, the Association continued to grow in importance, in influence, and in numbers. Then, in December 1936, Harry Jordan was drafted by the Board of Directors of the Association and accepted the position of Secretary-Editor. A trained water works chemist, a practical water works man, Jordan had been Secretary and then Chairman of the Water Purification Div. as well as President of the Association. Devoting his great energy and keen intelligence to furthering the importance and influence of AWWA, fully supported and finely helped by a wonderful group of presidents succeeding one another, and always supported unanimously by an attentive Board of Directors, Harry Jordan has been the spark plug of this organization for the past sixteen years, a fact which was recognized last January by naming a new award—the highest honor which the Association can convey—the Harry E. Jordan Achievement Award.

The 3,000 membership mark was passed in 1938, a growth of 1,000 members in fourteen years. This year, the Association membership passed 9,000, a growth of 6,000 members in fourteen years. More than half of that membership is comprised of active water works executives.

During these years the strength, resources, and activities of the Association have continually increased. Its meetings gain in importance through their programs and attendance. Between 7,000 and 8,000 make up the total attendance at the meetings of the

28 sections in this country, the one in Canada, and the one in Cuba.

Numbers as such have but little significance—they mean little unless coupled with accomplishment. There is real evidence of accomplishment, however, in the influence that the American Water Works Assn. has attained through its divisions, its sections, its committees, its publications, and its annual conventions—an influence that was able, on sheer merit, to bring about establishment, a year ago, of the Office of Water Resources in the National Production Authority.

### Cooperation of Manufacturers

The part the manufacturers have played is real too! Believe it or not, when the Association was formed the manufacturer members were termed "Honorary Members." Four of them participated in the 1881 meeting. In 1882 when the meeting was held at Columbus, Ohio, there were fifteen Honorary Members, all manufacturers. They could not vote but, with permission, could address the Association upon topics pertaining to their respective vocations.

It is interesting to note, in passing, that as a part of the entertainment of the 1882 meeting, the members were invited to the office of the *Ohio State Journal* to witness the practical working of the Edison electric light and that Noah Thomas, warden of the penitentiary at Columbus, "extended the courtesies of that institution to the Association and to its members."

From the *Proceedings* of the Fifth Annual Convention, held in Boston in 1885, the following is quoted: "It was soon evidenced that the water delegates who were present were averse to any connection with our Cochituate

water supply. The sherry, sauterne, and sparkling champagne were provided literally as free as water." Perhaps that accounts for the fact that, from that year forward, the manufacturers were titled "Associate" and no longer "Honorary."

Apparently the manufacturers were bearing a considerable portion of the expense of entertainment. Some Associate Members objected to some degree, as the minutes of the 1891 convention at Philadelphia show. There, resolutions were offered limiting the receipt of entertainment. These resolutions were not passed, but one that was passed, read: "RESOLVED: That the Committee on Arrangements accept no invitations that will interfere with three solid days of the convention."

### Solution of Entertainment Problem

The practice of having manufacturers provide the entertainment and pay for it continued for a number of years. Perhaps it was getting out of hand by 1908 when the minutes show that the representatives of sixteen associate members met on May 14 during the Twenty-Seventh Annual Convention of the American Water Works Assn. at Washington to "organize an association of supply men to take care of the entertainment features and exhibits at the American Water Works Assn. convention."

Incidentally, in reviewing the history of meeting entertainment, it is of interest to note that the 1908 meeting included an address to the general convention by Vice-President Fairbanks; a ball with music provided by the United States Marine Band; and a reception by President Theodore Roosevelt at the White House.

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The first annual meeting of the newly organized Water Works Manufacturers' Assn. was held on January 11, 1909, in the old Astor House in New York City. Thirty charter members were represented. Denis F. O'Brien of the A. P. Smith Manufacturing Co.—that fine, dear, cultured gentleman whose passing a few years ago was mourned so deeply by those who knew him—was elected the first president. At the 1909 AWWA convention at Milwaukee, the first convention at which the new manufacturers' association functioned, 30 members exhibited. The manufacturers' entertainment committee planned, managed, and paid for all entertainment and entertainment features, including the annual banquet. This procedure continued for twenty years, and some of the entertainment features still linger fondly in the memory of many old-timers.

There developed a considerable and understandable desire on the part of the officers and directors of the American Water Works Assn. to have the entertainment features of the annual meetings a responsibility of the Association, rather than of the manufacturers, and to have each convention self-supporting insofar as possible. After many conferences between representatives of both groups, guided by George W. Fuller of AWWA and Denis F. O'Brien of the manufacturers, the Association in 1929 formally took over from the manufacturers the entertainment features of the convention, decided to charge all persons in attendance a registration fee, and required "that banquet tickets be purchased by those who attend and not be given to persons in attendance by the Manufacturers' Assn." The quota-

tion is from the minutes. At the same time, the AWWA officially accepted the proposal of the Manufacturers' Assn. that an annual payment in the amount of \$7,500 be made to AWWA "in lieu of furnishing entertainment at annual conventions." That procedure has been followed consistently since that time. The Kansas City Conference was the twenty-second consecutive convention to stand on its own feet and be self-supporting—actually self-supporting too, for the \$7,500 annual payment from the manufacturers goes into the general fund of the association and is not earmarked for convention purposes.

#### **Improved Convention Planning**

Shortly after this procedure was adopted, two other forward-looking steps were taken to promote better conventions. First was the creation of the Convention Place Committee comprised of the three most recent past presidents of AWWA and the three most recent past presidents of the Manufacturers' Assn., with the Secretary of the AWWA as chairman of the committee. The old practice of determining convention sites by selecting the city which made the biggest demonstration at the general meeting was replaced by a studious approach to the facilities, availability, and area of cities proposed. This committee makes its recommendation to the Board of Directors of the American Water Works Assn. and with that board rests the final decision in determining where the conventions are to be held.

The next step forward was the creation of a Convention Management Committee of five, all appointed by the American Water Works Assn., three from its own rolls and two from

the Manufacturers' Assn. This committee has the job of preparing a budget, living within it, setting up all entertainment features, and, in general, running the show. The committee is always actively assisted by a larger number of members, both active and associate, who willingly assume various segments of responsibility. The result is a great coordinated effort that clicks.

### Manufacturers' Association

The Water and Sewage Works Manufacturers' Assn.—and it assumed that name in 1940 at Kansas City following the nationalization of the Federation of Sewage Works Assns.—is incorporated under the laws of the state of New York. It is not a trade association in any sense of the word. Its sole purpose is to operate exhibits and to advance the interests of its members and the water works and sewage works associations which it serves.

The Manufacturers' Assn. is governed by a Board of Governors of fifteen, five elected each year for three years. It is a democratic organization. No board member can be re-elected after he has served two consecutive terms. Its officers are elected annually for one-year terms. It operates under a Finance Committee with a budget drawn up and approved by the board. Association offices are maintained in New York City with a full-time manager and a full-time secretary. This year's budget for the management and overhead of the Manufacturers' Assn. is approximately \$70,000.

Membership eligibility requires that the applicant be an Associate Member of the AWWA, the New England Water Works Assn., or the Federation

of Sewage and Industrial Wastes Assns. No manufacturer who is an Associate Member of AWWA has ever been denied membership. The practical veto power of membership in the Manufacturers' Assn. lies with the associations that it serves.

Six annual exhibits are sponsored: the exhibits at the annual meetings of AWWA, the New England Water Works Assn., the Federation of Sewage and Industrial Wastes Assns., the California and Southwest Sections of AWWA, and the New Jersey Sewage Works Assn.

Just as AWWA tries to make its conventions self-supporting, so do the manufacturers try to make each exhibit self-supporting and also carry its proportionate share of the overhead. In recent months there has been some pressure to extend the number of exhibits held by the manufacturers, and a joint committee is studying that matter. If the present list is extended, the problem is where to stop! A partial survey covering but 38 states and three provinces of Canada, shows that meetings of water works, sewage works, and industrial waste groups, short schools, leagues of municipalities, and engineering organizations, where exhibits could and probably would be requested, total 487 in one year. It is a real problem.

In cooperation with the sections, when requested, the Manufacturers' Assn. sponsors, at its expense, various hospitality hours, social hours, and clubroom entertainments, as open house gatherings for all to attend. These functions are planned by joint committees representing the manufacturers and the sections.

Through all of these years the closest cooperation and friendship has ex-

isted between the AWWA and the manufacturers, an association that has been of great benefit to all. The relationship has here been described as a fellowship, which is defined in the dictionary as "the condition of being sharers or partakers, a community of interest."

### **A Profitable Relationship**

What is the result? Here you find water works men, consulting engineers, and manufacturers working shoulder to shoulder to make the water works industry and the job of the water works man better. Through the years many sections have honored qualified manufacturers and manufacturing men with section office. Two of the 30 directors now representing the sections—and it is the directors representing the sections who act as a nominating committee to perpetuate the administration of the Association—are manufacturers. Of a total of 242 section offices, fifteen are filled by manufacturers' men. The 53 working committees of the AWWA have a total membership of 485, and, of these, 73 are manufacturers, in there pitching just as hard and just as faithfully as anyone else in a common cause.

Why are these manufacturers' men serving, some of them in the most valuable way? Because they are recognized. Because there is no gulf divid-

ing them and the water works men. They get satisfaction out of their recognition, and they earn it through honest effort.

It has been said that this relationship is without counterpart. An active and long experience in manifold fields of activity has failed to show in any other branch of endeavor a similar and successful fellowship. To the contrary, in many associations the sessions are closed. Commercial men are banished. There are sessions where manufacturers' men are told to get up and get out so that so-and-so may be discussed. One association with a fetish against commercialism will not permit, however great his knowledge or his skill in research or performance, any manufacturer's man to appear on any program at any time to discuss anything. What is the result? Manufacturers' men get nothing out of it, no appreciation, no opportunity to cooperate, so they put nothing into it. There is none of the fellowship that exists in the water works field, none of the cooperation, none of the mutuality of interest, and, as a consequence, there is not comparable progress.

The water works industry needs this continuing, understanding, driving co-operation from all of us, and such co-operation will continue to keep American water works and the American Water Works Assn. in the forefront.

# Relocation of Water Works Facilities in Highway Construction

By Harry B. Shaw and G. H. Seig

*A panel discussion presented on May 9, 1952, at the Annual Conference, Kansas City, Mo., by Harry B. Shaw, Chief Engr., Washington Suburban Sanitary Com., Hyattsville, Md., and G. H. Seig, General Attorney, Metropolitan Utilities Dist., Omaha, Neb.*

## Engineering and Financial Aspects—Harry B. Shaw

THE subject of payment for utility changes resulting from highway construction is one of increasing importance to the utilities of this country. The development of the automobile with the concurrent high standard of living has created traffic problems throughout the nation which necessitate drastic changes in the highway systems. The availability of private transportation to the general public, with its attendant conveniences, has brought about major changes in transportation which have resulted in the congestion of streets and highways by automotive vehicles to the point that state and federal governments have been forced to act to relieve the intolerable situation. The increasing use of trucks for all sorts of hauling, including their frequent substitution for rail transportation, and the growing use of buses for mass transportation greatly aggravates the traffic problem.

### Need for Highways

In order to answer the demands of modern automotive traffic, streets are being widened, straightened, and regraded; grade separation structures are being provided; multiple dual-lane highways, built; service roads, required; and wider highway rights of way, acquired. In making each of these improvements, the highway peo-

ple naturally have as a first consideration the creation of a highway that will best meet their concept of particular needs. It would be completely unrealistic and indefensible for water utilities not to recognize the need for highway projects; as citizens and taxpayers utility men should support them when the need is established and the concept sound.

The improvement or creation of these streets and highways usually results, however, in the necessity for making changes in the utility systems in the areas which the highways traverse. Again, the water works profession should not object although it may cause trouble and inconvenience, but should consider it a part of the job. The construction of the improved highway or street may force the premature construction of utility structures in order to avoid expensive construction later within the limits of the highway improvement. Such premature construction may present serious problems, and is generally undesirable from a utility management standpoint, but at least there is the alternative of whether or not it is better to do it before the highway is improved, recognizing that the construction, although premature, will eventually bring in some return on the investment in it.

When utilities are told to relocate, raise, lower, rebuild, substitute, build additional, or abandon their existing structures without full compensation therefor, however, it is time to call a halt. It requires no legal expert to note that when a utility is forced, at its own expense, to make system changes by which it does not benefit, and which are required by no act of its own, an injustice is done. Such an expense is unfair and confiscatory and imposes a double burden upon the utilities' customers, who have already been taxed for the highway improvement and are then required to assume the special cost of utility structure relocation made necessary by the highway improvement.

### Absorbing the Cost

The only methods by which a utility can itself absorb the cost of making the changes necessitated by highway construction are by transferring the cost to its consumers in higher rates or by taking the cost out of surplus or profits. Neither method is equitable. If the utility is municipally owned, a tax could be added to the general tax, but that is just calling it by another name, and doesn't alter the basic injustice of the practice at all. However it may be observed by the utility, the cost of making the changes in utility structures necessitated by highway construction results in a poorer balance sheet for the utility by showing higher rates than necessary to obtain a satisfactory operating surplus or by showing an unsatisfactory operating surplus or even a deficit. This balance sheet affects the utility's credit and its ability to borrow money for its legitimate needs. If the utility is small, or operating on a close margin, its actual solvency may be affected.

### Effect on Consumers

That the cost of utility changes necessitated by highway construction will seriously affect the utility's customer is not an idle theory, but is borne out by statements from the hearings before a subcommittee of the Committee on Public Works of the U.S. Senate, on Senate Bills 2437 and 2585 (1). Edward T. Gignoux, Counsel for the Maine Water Utilities Assn., said:

Perhaps it would be most helpful this afternoon if I merely cite to the committee a few of the figures which were obtained in the poll which the Maine Water Utilities Assn. undertook last winter.

Probably the most glaring example is that of the Lincoln Water Co. in Lincoln, Me., a small town, a small company, with 630 customers. The gross utility revenues of the company in the year 1949 amounted to \$30,000. The net operating income in round figures was \$3,000.

In that year Route 2, running from Lincoln to Lincoln Center, which is a part of the main highway from Bangor, Me., to Houlton, Me., which I assume is not familiar to the Senator from Florida, in which federal funds were involved, under reconstruction and the cost of relocating the facilities of the Lincoln Water Co. in the right of way amounted to \$15,000 or 50 per cent of the total utility operating revenue of that company in that one year.

On a per customer basis that was \$22 per customer. Under the federal law and the Maine law, there was no reimbursement to the company and the rate payers for that expense.

Later Mr. Gignoux said:

The Augusta water district in the year 1950 was required to relocate its mains as a result of reconstruction of the highway between Augusta and Waterville, Me.; the Augusta water district had 6,000 customers that year. The cost of reconstruction amounted to \$15,000. The per capita cost per customer, \$2.50.

The Mars Hill Water Co., Mars Hill, Me., 508 customers. In connection with the reconstruction of Route 2, in 1948, it was required to relocate its facilities at a per customer cost of \$7.25.

Although Mr. Gignoux's statements cite severe examples, there are also many other places throughout the country where the burden imposed upon the utilities is just as severe, for the problem is national in scope, as illustrated by the examples that follow. Mayor Haydon Burns of Jacksonville, Fla., at the same Senate hearing (1, p. 477) said that the estimate of the state road department for the cost of removing Jacksonville's utilities was between \$1,500,000 and \$2,000,000. Other normal expenses on abutting streets would increase the total to \$3,000,000, but even the low figure of \$1,500,000 for utilities in the affected roads alone would be enough to disrupt the city's current budget, and several fiscal budgets in the future.

Robert L. Lawrence, Jr., Director of the water works department of Nashville, Tenn., stated at the same hearings (1, p. 503) :

. . . the city of Nashville, Tenn., through its water works department, has expended since 1945 approximately \$120,000 on its facilities in connection with the construction of federal-aid highways.

The placing of such an expense upon a municipal function is, in effect, the placing of a burden either upon the water consumers or the taxpayers of Nashville. The budget of the water works department of the city of Nashville is only a subdivision of the general municipal budget and any unusual or unreasonable expense placed upon the water works department is a drain upon the municipal budget and is in turn a burden placed upon the taxpayers of the city of Nashville.

G. H. Seig, in referring to Omaha, Neb., has stated:

During the past 4 years this Metropolitan Utilities Dist. has been put to expense in excess of \$100,000 for relocating water and gas mains and appurtenances thereto resulting from federal-aid highway projects within the city of Omaha alone. Several federal-aid highway projects within the city of Omaha are now pending and when constructed will similarly require expensive changes and alteration to the water and gas mains.

In cities like Omaha, gas and water mains are generally laid under a special assessment procedure, abutting property owners being required to pay a portion of the cost. The mains in many cases have a life of a hundred years or more. Relocation is not contemplated when they are laid, and there is generally no provision to cover the cost thereof. In our case all of the rate payers have borne the burden.

#### **Suburban Washington Problem**

The Washington Suburban Sanitary Com. is also confronted in not exactly a minor way with the same financial problem. It is now spending an estimated \$32,600 for relocating utility structures in a federal-aid highway project; it recently spent \$35,600 for similar work on a state road project, and is continuously spending money for adjusting structures on other state and local projects. In April 1952 the commission was informed by the Bureau of Public Roads that it was expected to make the necessary changes in structures, without reimbursement, that are required by the Washington-Baltimore Parkway being constructed by the federal government between Washington, D.C., and Jessup, Md., which traverses an area in which there are numerous utility installations.

The author has been informed that in Kansas City, Kan., for one highway project in 1948, a water utility paid more than \$33,000 for changes in its water mains. Space does not permit a further recital of the many incidents

in which utilities have been burdened with the cost of changing their structures because of federal or federal-aid and state highway work. The problem has grown to such proportions that it is seriously menacing the water works industry.

### Growing Problem

It must be emphasized that this menace to the financial structure of the utilities of the country will grow much more serious unless it is curbed. Unless a calamity occurs, the increasing American population will require more automobiles, and automobiles require more and improved streets and highways, and these will be built. Also the modern industrial civilization has created the phenomenon called the metropolitan area and will continue to create more and more of them. These increasing concentrations of population around the existing population centers will increasingly require more and more highways of elaborate engineering design which will require more and more expensive changes in utility structures because they will traverse the areas wherein utility systems are concentrated. If some utilities have not yet encountered this problem, they should not be complacent because the odds are high that they will. All utilities should do something about the situation promptly. The problem is not one of the remote future. It is here—now.

### The Utilities' Case

The utilities case is a sound one. Utilities operate essential public services, which are constructed largely in public thoroughfares and which operate primarily for the public benefit. The systems are legally built in the public thoroughfares and that is where they should be because the public can be

most economically, conveniently, and effectively served thereby. The utility operates at cost to the public or at a rate that a publicly controlled supervisory body says is fair. Financing is based upon the cost of installations which are generally adequate to meet the demands upon them. The finances of the utility are usually adequate until a highway project is started through the area in which the installations are located. The utility is asked to change its structures to conform to the highway construction at its own expense, although by doing so it will neither improve its system nor provide better service to its customers. The utility does not have any jurisdiction in locating or designing the highway but is told to move its structures as the highway plans require, regardless of the effect of the resultant costs upon the utility, either in rate adjustment or in financial structure. This situation prevails generally all over the country. The obvious inequity that exists places the utilities in a good position to do something about the matter.

Actually the problem must be dealt with at three levels—federal, state, and local. The federal government, through its public roads agency, constructs highways and exercises control over much of the state highway construction by means of the federal highway aid program. The matter of payment for utility changes necessitated by federal-aid highway construction seems to lie both with the states and with the federal government, as indicated by General Administrative Memorandum No. 300 of the Federal Roads Administration, dated May 1, 1946, which states that utilities will be reimbursed out of federal funds in the amount of the federal prorata share for changes in its structures made necessary by the federal-aid highway project, if the state for-

mally finds that the utility is not obligated to change its facilities.

### The Federal Level

The first step in alleviating the inequity should be the passage by Congress of an act which would provide, in effect, that the federal government shall pay the federal prorata share of the cost of the utility changes made necessary by the highway project. Such an act would prevent the question of payment from being a matter of administrative decision and would take the matter of the federal contribution out of the hands of the state highway departments where it never should have been. It is not considered good policy in this country for the same party to be both judge and jury.

A good start was made when Senator McKellar of Tennessee introduced Senate Bill 2585 in the Second Session of the 82nd Congress. The author feels the bill should be revised to make payment of federal funds for utility relocations mandatory and not permissive, although it should not require the federal government to contribute more than the applicable federal prorata share of the cost of the highway project. To the author's knowledge, no formal action on this bill has been taken thus far. If the bill fails to pass, or if it is passed in an unsatisfactory form, a bill which will encompass the purpose the utilities desire should be introduced in both houses of the next Congress early in the session. The case of the utilities should be carefully presented to the proper committee of each body and the bill should be followed through the Congress until it is passed. This procedure is not simple. The utilities should get together at the national level, prepare their case, assign a committee representing the respective groups and provide it with

the needed funds so that the necessary legislation may be introduced and properly followed through both bodies of the Congress until it is passed.

### AWWA Action

It must be remembered that the senators and representatives must be advised by the various utilities in their respective constituencies of the importance of the pending legislation to the utilities and their strong support of it, so that the congressmen will be properly impressed with its merits when it comes before them for action in committee or on the floor. In the AWWA this can best be accomplished by establishing a committee in each section which will encourage the section members to furnish their representatives in Congress with factual data supporting the utilities' position. These AWWA section committees should cooperate with corresponding committees in other utilities in their area to insure that the other utility members also present the facts to their congressmen.

### The State Level

If the federal problem is solved in the manner suggested, the utilities must realize that the job is only partially completed as federal and federal-aid highway projects represent only a minor part of the problem. The state and local problems must still be resolved. The procedure to be used with the states should be similar to that used with the federal government, except that it must be handled with state legislatures and hence will involve many times the work and will involve the rank and file of the utilities much more intimately. The details of the suggested procedure to be followed in handling the matter on the state level have already been given (2). The author would like to

add, however, that the section committees could render valuable service in coordinating and encouraging the efforts of their constituent section members and in arranging the presentation of the utilities' case to the state legislatures. The job should not be left entirely to the section committees, however, as nothing takes the place of the individual's contact with his legislative representative. The author would like to see a bill presented at the next session of each state legislature that has not already taken favorable action in the matter, which would require the state highway body to pay for utility changes necessitated by its highway activities.

If the desired legislation is passed by Congress, and if each state legislature passes similar legislation, the utilities will be relieved of this externally imposed burden at the state and federal levels, and the customers will be relieved of the burden of double taxation created by highway construction.

### The Local Level

After the federal and state problems are solved, there will still remain a problem at the local level. It will not be discussed here as it has too many ramifications. Every utility should go into the problem, however, as a basic principle is involved. Even if the water utility operates a municipal de-

partment, the water department should not be charged with costs which are not of its own making and from which it does not benefit.

### Conclusion

The problem is tremendous but it can be solved. The position of the utilities is sound and some of the states have already recognized the justice of it by enacting suitable legislation. *Magna est veritas et prevalebit.* "Truth is mighty and it will prevail." The utilities must remember, however, that, as with all worth-while causes, there is powerful opposition abroad in the land, some of it sincere and, of course, some of it selfish. It therefore behooves all of those who operate or are otherwise concerned with utilities to get together and put forth their best efforts so that the injustice of requiring utilities to pay for changes in its systems which result from highway projects will be removed, and so that the people who are otherwise served so well will be relieved of an unfair burden.

### References

1. Senate Bills 2437 and 2585. Hearings Before Subcommittee of the Committee on Public Works. U.S. Senate, 82nd Congress, Second Session.
2. SHAW, HARRY B. Payment for Utility Changes in State Highways. Jour. AWWA, 43:496 (July 1951).

### Legal Aspects—G. H. Seig

The factual portion of the utility relocation problem has been thoroughly covered by Harry B. Shaw, both in the preceding article and in a former paper (1). This author's remarks, therefore, will be confined to legal questions involved in obtaining reimbursement for damage to, or relocation of, water mains resulting from street and highway paving, and other projects.

### Recognized Principles

Forty years ago Judge Dillon said (2):

Water Pipes and Mains. A supply of water for a populous place is a service of a clearly recognized public character, and is generally regarded as a proper municipal function. The privilege of using the streets or highways of a municipality for

water pipes and mains can only be exercised by a person or corporation having the right conferred upon it by statute. Where the charter gives to the city the power to supply, or authorize the inhabitants to be supplied with water, the municipal council may use, or, as an incidental power, may permit the contractor to use, the streets for this purpose, and the adjoining owner, although he holds the fee to the center of the street, is not entitled to compensation as for a new servitude; for it is not such, but *only a proper or necessary use incident to a street in a populous place*.

**Conflicting Franchises.** Every corporation which acquires a franchise to use the city streets which is not by its terms or true construction shown or declared to be exclusive, takes the franchise subject to the power of the legislature or the city to grant similar rights to others. But as between two companies exercising similar rights, *priority of possession confers superiority*. The corporation or individual first installing its pipes, mains, or appliances, acquires certain superiority of rights in the use of the city street therefore. Each company may exercise its own franchise as fully as is compatible with the necessary rights of others, but where any interference is unavoidable, the later occupants must give way. But the first occupant of the streets is only protected against unreasonable and unnecessary interference.

Today, the law in most states acknowledges the foregoing principles. The problem seems to be that of demonstrating that any interference with water mains brought about by the subsequent construction of super highways, viaducts, subways, and sewers is unreasonable if the water utility is required to pay the cost of its elimination.

#### Various State Statutes

In New Jersey the legislature has recognized this inequity. The New Jersey statute relating to freeways and

parkways provides that whenever the State Highway Commissioner determines that it is necessary that facilities be relocated or removed, the utility shall relocate or remove them, and the cost and expenses of such relocation and removal, including the cost of installing such facilities in a new location, shall be paid by the State Highway Commissioner.

California, in 1947, enacted a statute which provides that relocation of utilities in state freeways shall be paid for out of the state gasoline tax. That statute saved the city of Los Angeles approximately \$700,000 for relocating its water and electric facilities along the Hollywood Freeway, and the city of Pasadena reports that the state is now constructing a freeway into Pasadena and has assumed the cost—\$70,000-\$80,000—of changing the water facilities.

Under Regulation 300 of the Federal Bureau of Roads, 50 per cent of utility relocation costs are paid out of federal funds. Regulation 300 allows such costs in those states in which local law permits or requires the state or city to pay them as part of the construction cost of a highway improvement.

In some states the highway department or the city has recognized, by contract, that the utility changes were a proper part of highway construction, and the costs have been borne equally by the city or state and the federal government.

In Indiana, however, the deputy attorney general has recently construed the state statutes as follows:

The rights of the public in and to highways are paramount to the privilege of the owners of the utilities who place and maintain equipment within the limits thereof. In other words, the owners and operators of public utilities never acquire easement rights in and to highways or

streets; and equipment so placed within public highways is subject to regulation or removal in the interests of proper construction and maintenance of the highways for primary use for which they are designed and laid out—that is, for public travel.

Unfortunately, that archaic concept still prevails in many of the states and cities. It completely ignores the vast changes in highway and street uses made necessary by modern conditions.

#### Public Use

Modern cities cannot exist without water. Conveying it to the inhabitants is every bit as important and essential as public travel. Water is delivered through pipes laid below the surface of streets and highways. The motoring or traveling public uses only the surface. The use of the subsurface does not prevent use of the surface. When a utility does interfere by cutting pavements, for instance, it restores the pavement at the expense of its rate payers. All the utilities ask is reciprocal treatment. When the traveling public desires to use a highway or street in such a manner as to interfere with the prior use which utilities lawfully have in it, it should act as the utilities act, and pay all of the costs which its new use forces upon them. The gasoline taxes and auto license fees which the traveling public pays to build and maintain its modern highways are available for this purpose.

The streets and highways belong equally to the water-using public and to the traveling public, but the legislature has paramount authority to regulate their use. When the legislature by statute, or a city by franchise, grants to a water utility the right to utilize highways and streets for its mains, the courts generally have held that the

utility acquires an easement, which is a property right, as several decisions show.\* Actually, the traveling public also has only an easement because, upon the vacation of a street, the area which it occupies generally reverts to the abutting property owners. It seems to the author, therefore, that the right of the utility to make a certain use of the street and the rights of the traveling public are equal.

#### Police Power

The police power is frequently relied upon in justification of a demand by the state or city that the utility remove or relocate its installations at its own expense. An example of the resort to police power is the case of *Los Angeles v Los Angeles Gas & Electric Corp.* (251 U.S. 32, 40 S. Ct. 76, 64 L. Ed. 121) in which the city of Los Angeles, by ordinance, attempted to force the Los Angeles Gas & Electric Corp. to remove or relocate its poles and other property in the public streets of the city in order to facilitate the construction by the city of a municipal electric street lighting system. When the validity of the ordinance was attacked, the city declared: "[The] ordinance is urgently required for the immediate preservation of the public peace, health, and safety." The trial court rejected this contention, and the U.S. Supreme Court affirmed, saying:

\* See *Russell v Sebastian* (233 U.S. 195, 34 S. Ct. Rep. 517, 58 L. Ed. 915, L.R.A. 1918E, 882, Ann. Cas. 1914C, 1282); *Boise Artesian H. & C. Water Co. v Boise City* (230 U.S. 84, 57 L. Ed. 1400); *Old Colony Trust Co. v City of Omaha* (230 U.S. 100, 33 S. Ct. 967, 57 L. Ed. 1410); *City of Louisville v Cumberland Telegraph & Telephone Co.* (224 U.S. 649, 32 S. Ct. Rep. 572, 56 L. Ed. 934); and *Southern Bell Telephone & Telegraph Co. v City of Nashville* (243 S. W. (2d) 617).

In what way the public peace or health or safety was imperiled by the lighting system of the corporation, or relieved by its removal or change, the court was unable to see, and it is certainly not apparent.

In addition, the U.S. Supreme Court held:

The city is subordinate in the right to a private corporation which was an earlier and lawful occupant of the field.

A municipality may not, consistently with U.S. Constitution, 14th Amendment, as a matter of public right, clear a space for the construction of its own street lighting system by removing or relocating the instrumentalities of a privately owned lighting system occupying the public streets under a franchise legally granted, without compensating the owner of such system for the rights appropriated.

More recently, in the case of *City of New York v New York Telephone Co.* (278 N.Y. 9, 14 N.E. (ed) 831), the city of New York brought suit for reimbursement of the cost of relocating the wires, conduits, and other structures of the telephone company which were located on a street in Brooklyn and which were put in originally under a valid franchise. The city operated the municipal subway and it determined that public convenience and necessity required the removal of a mall in the street and the repaving of the street to provide an unobstructed highway. To accomplish the street improvement it was necessary to remove the subway entrance from the mall. In denying reimbursement to the city, the court said:

No authority has been delegated by the legislature to the city as owner of the subway to require relocation of public utility facilities at the expense of the utility. In relocating defendant's under-

ground structures, the city acted solely in its proprietary capacity as owner and operator of the subway under the provisions of the Rapid Transit Act, and having acted in that capacity, it must bear the cost.

It will be observed that both of the foregoing decisions held that the utilities could not be required to remove or relocate their facilities because the city was not acting under its police power, but in a proprietary capacity. This poses a question: if it is wrong when the city acts in a proprietary capacity, why isn't it equally wrong when it acts in a governmental capacity?

#### Favorable Decisions

In the case of *Boise Artesian H. & C. Co. (supra)*, it is stated:

The grant of the right to lay water pipes upon the streets for the purpose of distributing water, found in the ordinance of Oct. 3, 1889, purports to be nothing more than a grant of the right to occupy the streets of the city with the distributing pipes of the water company. It was accepted, and about \$200,000 has been expended in the construction of the necessary works and the laying of its system of pipes under the streets. The assertion of the right to require the company, after so many years of occupation, to pay a monthly rental for the use of the streets, is grounded upon the claim that under the grant to the Eastmans it had obtained nothing more than a revocable license, and its occupation of the streets was therefore subject to be terminated at any time.

The right which is acquired under an ordinance granting the right to a water company to lay and maintain its pipes in the streets is a substantial property right. It has all of the attributes of property. . . .

The grant was made in contemplation of the investment of large capital in the construction of a system of water works for the permanent supply of the city with

water. The presumption is that no such enterprise would have been entered upon if the street easement was subject to immediate revocation. . . .

For the purposes of this case we need go no further than to hold, as we do, that the street easement was not a mere revocable license. . . . The plain effect of this later ordinance was to impair the obligation of the contract resulting from the ordinance conferring the street easement.

In the case of *Southern Bell Telephone & Telegraph Co. v City of Nashville* (*supra*) which was decided on May 30, 1951, by the Court of Appeals of Tennessee, middle section, the city adopted a resolution ordering the telephone company to relocate, at its own expense, its telephone facilities at a point where the Dept. of Highways and the Federal Bureau of Roads had a project the purpose of which was the construction of a bridge over the tracks of a railroad company in order to eliminate a dangerous crossing. In holding that this resolution and action of the city was invalid and an attempt to unlawfully exercise the police power of the city, the court said:

The only way the defendant could justify the passage of the resolution in question would be that it was a valid exercise of the police power of the city.

The rights of the complainant company to maintain its wires in Minnesota Avenue constitute property rights which are protected by both the Constitution of the United States and the state of Tennessee and of which complainant cannot be deprived without due process of law.

While this right to occupy the streets is a property right of the complainant, it is subject to the valid exercise of its police power by the defendant city. In order to be valid this exercise of its police

power must not be unreasonable and arbitrary and its exercise must have a reasonable relation to the end sought to be attained, which in this case is the elimination of a grade crossing. . . .

In this case the complainant has complied with all its obligations under its franchise granted by the city. Its facilities in Minnesota Avenue were in underground conduits; were not a source of any danger; the complainant did not benefit in any way by the required changes in the location of its conduits; all other utilities were reimbursed for the expense of relocating their facilities; the elimination of this grade crossing was not a project of the city of Nashville under its police power or any of its charter provisions, but a project of the federal government for the benefit of the public and the railroad company, which was to be paid for by the government; and we find no merit in the attempt of the city to single out this complainant and attempt under the police power to force it to pay the cost of relocating its facilities.

### Conclusion

The author submits that inasmuch as the right which a state or a city has given to a water company to utilize the streets for the laying of water mains to serve the inhabitants is a property right, in the nature of an easement, and that it amounts to a contract which cannot be impaired, there is no valid reason, in law, why a utility should be required to remove or relocate such mains at its expense.

### References

1. SHAW, HARRY B. Payment for Utility Changes in State Highways. *Jour. AWWA*, 43:496 (July 1951).
2. DILLON, JOHN F. *Commentaries on the Law of Municipal Corporations*. Little, Brown, & Co., Boston (5th ed., 1911). Sec. 1212.

# The Electrochemical Desalting of Sea Water With Permeselective Membranes—A Hypothetical Process

By **Wilfred F. Langelier**

*A contribution to the Journal by Wilfred F. Langelier, Prof. of San. Eng., University of California, Berkeley, Calif.*

**I**N a discussion of a recent paper on sea water reclamation (1) the author referred to the electrical properties of resinous ion-selective membranes and made several suggestions for the use of these membranes in the desalting of brines. The material contained herein is an elaboration of these earlier comments. It is hoped that the suggestions may be of some value to those contemplating experimentation with the new membranes which are expected to become available in the near future.

## Electrochemical Theory

Figure 1 shows a demineralizing unit based upon the use of known materials and involving elementary electrochemical theory. The figure is not drawn to scale and is intended to show only the basic principles involved in the process. Under a suitable electromotive force from a direct-current generator or rectifier, electrons flow to an inert metal cathode which forms one side of an insulated tank that is initially filled with sea water or brine. The electrons are taken up by adjacent water molecules to produce molecular hydrogen and hydroxyl ions in accordance with the following reaction:



The current is carried across the liquid to the anode exclusively by the motion of dissolved ions, the anions of the salt moving to the left, the cations moving to the right. At the anode which forms the left side of the tank, electrons are taken from adjacent water molecules and are returned to the generator. The anode reaction results in the formation of molecular oxygen and hydrogen ions in accordance with the following reaction:



## Application

In the absence of the indicated ion-selective membranes, the application of an electromotive force to brine in an electrolytic cell would not result in the production of fresh water—rather it would produce a more concentrated brine. If, however, the tank is divided into three separate compartments or channels by the insertion of an anion-permeable (cation-impermeable) membrane parallel and adjacent to the anode, and a cation-permeable (anion-impermeable) membrane parallel and adjacent to the cathode, fresh water will be produced in the inner compartment or channel.

In the cathode compartment on the right (Fig. 1), the reduction of hydro-

gen ions to molecular hydrogen tends to create a state of electrical unbalance—that is, a greater number of anions than cations. Balance is maintained by the inflow of cations from the middle channel rather than by the outflow of anions because the membrane selected

inflow of anions from the central channel. In time, the middle channel will have lost most of its ions or will have become salt-free. Because of excessive power requirements, however, a three-compartment unit would probably be uneconomical to operate.

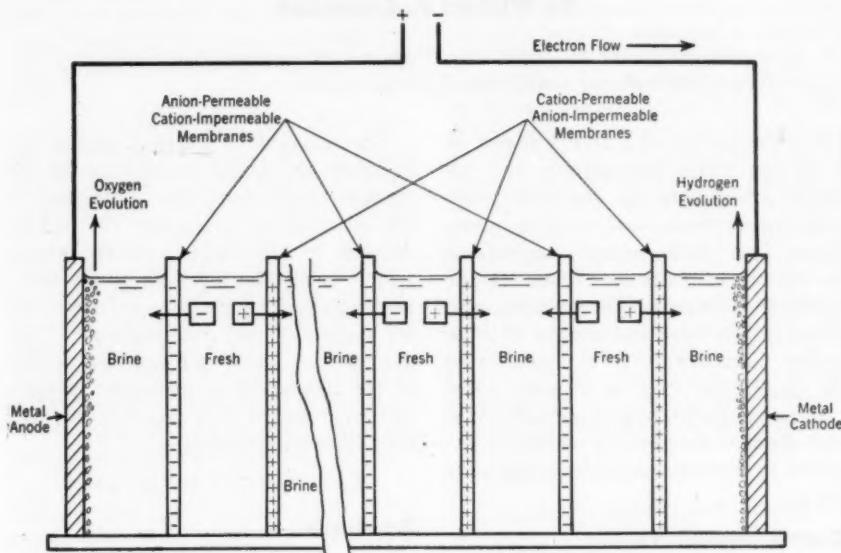


Fig. 1. Demineralizing Unit for Producing Fresh Water From Salt Water

From anode to cathode the current is carried exclusively by ion transfer. Decomposition of water molecules or salt ions occurs only at anode and cathode. Anodic reaction favors liberation of oxygen and production of acid brine. Electroneutrality is maintained by the inflow of anions. Cathodic reaction favors liberation of hydrogen and production of base. Electroneutrality is maintained by inflow of cations. Ion transfer in intermediate compartments is controlled by alternate arrangement of "one-way" membranes. Fresh water is produced in alternate compartments. Unit should comprise a large number of intermediate compartments or channels of minimum width. Water flows in countercurrent direction in alternate channels.

for this position is impervious to the movement of anions. Similarly, in the anode compartment at the left, the evolution of oxygen from the oxidation of hydroxyl ions results in the production of an excess of hydrogen ions. Electrical balance of the water in this compartment is maintained by the

Each equivalent of salt removed would require one equivalent of water decomposed at the metal electrodes. If, however, the central compartment were divided into a large number of equal compartments, each separated by membranes of proper selectivity, the equivalents of water decomposed at a rela-

tively high potential into hydrogen and oxygen per equivalent of salt removed will be reduced to a minimum. In a battery of cells comprising  $n$  compartments there would be  $\frac{n-1}{2}$  demineralizing compartments, each producing the same volume of desalted water.

### Production

Normal sea water contains approximately 600 milliequivalents of salt per liter. To produce a good quality of fresh water, 99.5 per cent of the salt should be removed. Expressed in more familiar terms, to produce 1 mil gal of fresh water from sea water, approximately 150 tons of salt must move through a membrane. The necessity for employing large membrane surfaces and thin water channels is thus apparent. An unnecessary voltage drop of as little as 0.5 v across each concentration cell (brine to brine) could make the difference between economic failure and success. The actual picture is not too unfavorable, however.

### Power Requirements

Assuming a current efficiency approaching 100 per cent, each thousand gallons of fresh water produced will require a current flow of approximately 60,000 amp-hr. The voltage or power requirement, however, is not as readily calculated and will depend upon a number of cell design factors. A considerable portion of the required voltage will arise from the electrical resistance of the freshened water. Calculations of cell potentials and ohmic resistances indicate that, under favorable design conditions, the average voltage drop per cell might be held to 0.5 v, thus requiring 30 kwhr of electrical energy per 1,000 gal of fresh water produced. This energy requirement is approxi-

mately one third that of the most efficient vapor compression distilling units now being manufactured.

### Construction

Another favorable aspect of the process is the fact that the units could be constructed almost entirely of molded plastics and rubber with a minimum of machined metal parts. It is reasonable to suppose that capital charges, and maintenance and other operating expenses would be materially less than corresponding costs of the competing distillation process.

### Water Softening

The electromembrane process does not appear to offer great promise in the field of municipal water softening because, in the electrical process, the cost per pound of salt removed increases rapidly as the "ion-free" condition of the water is approached. In any given situation, the economic limit of desalting will depend upon the value of the finished product. A householder requiring only a few cubic feet of soft water per day could afford to pay a rate many times the rate justifiable in a municipal or agricultural operation.

### Suggested Operating Unit

In the absence of a larger supply of experimental data, it is hazardous to predict the ultimate success of the new process. It is even more hazardous to suggest, beyond the merest outline, design features which might be incorporated into a practical working unit. The basic principles underlying the process are reasonably well understood, however, and certain deductions may not prove unwarranted.

A full-scale operating unit might be expected to have the outward appearance of a plate and frame filter press.

The two outer ends, anode and cathode, respectively, would be made of stainless steel or other good conductor resistant to deterioration. Between the anode and cathode there would be a considerable number—possibly 50 or more—plastic or other nonconducting frames and gaskets designed to hold the individual membranes in place and to prevent the membranes from bulging. Assuming a continuous-flow unit, the frames would form flow channels which should be very narrow, possibly 1 cm or less in width. The assembly would be held together with side lugs and would be mounted on horizontal bars well insulated from the floor.

### Precautions

In designing the unit, special care should be taken to insure against any possibility of electrical short circuits. Such special care should apply to the arrangements for the feeds and discharges to and from each of the flow compartments. Air-gaps could probably be made to serve this purpose. In addition, provision should be made to reduce short circuiting of the electrolyte in the flow channels. Such a reduction of short circuits could be accomplished by taking advantage of the progressive changes in specific gravity of the electrolytes by feeding the fresh-water channels at the bottom and the brine channels at the top. The counter-current operation obtained through this

provision should make for increased efficiency on its own account.

In the operation of the permselective-membrane process, chemical reactions other than changes in concentration of the electrolyte should not occur in any of the intermediate concentration cells. In the anode and cathode compartments, chemical reactions resulting from the decomposition of water molecules could be troublesome. Strong acid would be produced in the anode compartment and strong base in the cathode compartment. The production of a strong base in the cathode compartment would certainly cause the precipitation of calcium carbonate and magnesium hydroxide, either of which would coat the adjacent membrane and upset the working of the unit. This action could be prevented by feeding the cathode compartment with the acid effluent from the anode channel, but it would be necessary to guard against electrically short-circuiting the entire battery of cells. Other difficulties from clogging and leakage (1) are certain to arise. The author anticipates a rather long period of research and development in the production of improved membranes.

### Reference

1. HOWE, E. D. Sea Water as a Source of Fresh Water. *Jour. AWWA*, **44**:690 (Aug. 1952). LANGELEIER, W. F. Discussion. *Ibid.*, p. 697.

# Sizing of Services, Meters, and House Piping

By **S. Myron Tatarian**

*A paper presented on Apr. 18, 1952, at the California Section Meeting, Yosemite National Park, Calif., by S. Myron Tatarian, Asst. Superintendent, San Francisco Water Dept., San Francisco, Calif.*

THE engineer is confronted with three major sizing problems in the design and operation of any water supply system. These problems involve the determination of:

1. Feeder mains of adequate size to maintain water pressure in the distribution gridiron during the periods of maximum demand.
2. Distribution mains of adequate size to fulfill the requirements of both domestic supply and fire protection.
3. Services, meters, and house pipe of adequate size for each building.

The first two problems are entirely under the control of the engineer, but the third problem—the sizing of the services, meters, and house pipe—gives the superintendent of distribution his greatest trouble, and presents a situation over which he has little or no control.

The determination of the size of the service and meter, but not the house pipe, is the responsibility of the water company, but judging from the author's experience in San Francisco, the sizing of the service and meter is usually based on an "old Spanish custom" of what was good enough in grandfather's time is good enough today. Thus, no attention is paid to the difference between the type and number of plumbing fixtures in use today and

those of the past, no consideration is given to the water pressure available at the particular building for which the service and meter are required, and no attention is given to the length of the service required or the length of house pipe installed.

Many years ago in San Francisco the most common service installed was  $\frac{1}{2}$ -in. lead pipe. Later the size was increased to  $\frac{3}{4}$  in., and, finally,  $\frac{3}{4}$ -in. galvanized pipe was adopted as the standard for practically all residential and small commercial use. Sometimes as many as five  $\frac{3}{4}$ -in. meters were attached to a single  $\frac{3}{4}$ -in. service.

## Responsibility

As the water company's responsibility ceases at the meter, which, in California, is usually placed in the sidewalk area next to the street curb, it is obvious that the builder determines the size of the house pipe as well as the type of shutoff valve to be used. It is also obvious that the builder will install the smallest size piping and the cheapest type of control valve possible. As a result, practically all dwellings in San Francisco have  $\frac{1}{2}$ -in. house pipe with a globe type shutoff valve, regardless of the water pressure in the street or the quantity of water required in the building.

Today the consumer expects an ample water supply at all fixtures. He expects to be able to use any and all fixtures as his requirements demand. This situation has resulted in an increase in the maximum demand for water. The size of the services, meters, and house pipe should, therefore, be determined for the expected maximum demand for each particular building.

Assume that a new house has two and one half baths with flush-valve toilets and all other plumbing fixtures of the latest design, and that nothing has been omitted for the comfort and convenience of the occupants. The house is sold and occupied, the water having been turned on by the water company. Within a week or so troubles begin. The consumer calls the water company and complains of "poor pressure"—that when water is being used in the kitchen he can't use the shower, when watering the garden there is no water in the house, and that the toilets won't work. The water company then checks the water pressure and informs the consumer that the pressure is approximately 50 psi, and, perhaps, that he has a new  $\frac{3}{4}$ -in. service and a new  $\frac{3}{4}$ -in. meter, all of which are standard for a home. The consumer is probably informed, in addition, that there must be something wrong with the plumbing in the house, and that the builder should be consulted.

This information seems to satisfy the customer, but the next day he is back again, saying that he called the builder who sent a plumber to examine the plumbing, and that the plumber—who has been doing business for over 30 years—informed him that the trouble is simply lack of sufficient water pressure and that if the water company

would increase the pressure, everything would be all right.

Something is wrong. A superintendent of operations knows that he can't give more pressure even if he wanted to, and feels, justly, that 50 psi should be more than adequate pressure for a good supply of water to any house. He also knows that to tell the

TABLE 1  
*Fixture Units*

Fixture	No. of Fixture Units	
	Private Use	Public Use
Bathtub*	2	4
Dish Washer ( $\frac{1}{4}$ in. Outlet)	1	4
Kitchen Sink	2	4
Laundry Tray (1 to 3 Sections)	3	3
Showers*	2	4
Sprinkler Head†	1	
Toilet—Flush Valve	6	10
Toilet—Tank	3	5
Urinal—Flush Valve	3	5
Wash Basin	1	2
Washing Machine—Automatic†	2	
Outlet or Inlet for Plumbing Fixtures Other Than Those Listed Above		
$\frac{3}{8}$ in.	1	2
$\frac{1}{2}$ in.	1	2
$\frac{3}{4}$ in.	2	4
1 in.	3	6

\* When a shower and bathtub are in the same room, only one fixture should be counted in determining the fixture units.

† In public use, the number of fixture units depends on the size of the outlets or inlets.

customer that the plumber is wrong and that the builder is responsible for his troubles will result in a dissatisfied and, perhaps, irate customer. The superintendent of operations must have facts to support his opinion. A careful consideration of the problem indicates that several measures may eliminate the

TABLE 2  
*Flush Tank Closets*

Size of Pipe— <i>in.</i>		Pressure in Main <i>psi</i>				Max. Length of Service <i>ft</i>
Service	House Supply and Branches	30-45	45-60	60-75	75-90	
$\frac{3}{4}$	$\frac{3}{4}$	5	7	10	12	75
		4	6	8	9	125
		3	5	6	7	175
$\frac{3}{4}$	$\frac{1}{2}$	17	27	33	38	75
		12	17	22	27	125
		10	14	18	22	175
$\frac{1}{2}$	1	28	42	55	60	75
		21	34	41	50	125
		17	29	35	41	175
1	1	35	51	74	98	75
		27	37	47	61	125
		19	32	38	46	175
1	$1\frac{1}{4}$	51	94	135	140	75
		38	66	96	123	125
		32	53	75	96	175
$1\frac{1}{2}$	$1\frac{1}{4}$	76	150	208	260	75
		48	90	128	163	125
		37	65	92	120	175
$1\frac{1}{2}$	$1\frac{1}{2}$	137	240	340	380	75
		92	168	240	300	125
		70	130	183	236	175

recurrence of such complaints. It is imperative that:

1. Some means be developed for regulating and determining the size of the house pipe, and that this determination be based upon the available water pressure, the length of the house pipe measured from the meter to the last plumbing fixture, the number and type of plumbing fixtures installed, and the type of shutoff valve, when required.

2. Some program of inspection be set up in order to determine all the facts pertaining to any complaint.

#### San Francisco Ordinance

After many years of effort, in late 1951 the San Francisco Water Dept. succeeded in having passed and ap-

proved by the proper authorities an ordinance controlling the size of services, meters, and house pipe. This ordinance is based upon the Uniform Plumbing Code as adopted by the Western Plumbing Officials' Assn. The Uniform Plumbing Code was based upon two bulletins entitled "Building Materials and Structures" which were published by the National Bureau of Standards (1, 2). It was necessary to make some modifications of the code in developing the San Francisco ordinance in order to secure passage without too much opposition. The following specifications are included in the San Francisco ordinance:

1. Each plumbing fixture is given a relative value known as a fixture unit—a factor so chosen that the load-

producing values of different plumbing fixtures can be expressed approximately as multiples of that factor.

2. The minimum pressure for satisfactory service should be not less than 15 psi for flush valves and not less than 8 psi for all other fixtures (2).

3. If a pressure regulator is to be installed, all pipe size determinations must be based on 80 per cent of the reduced pressure.

The fixture units are given in Table 1 for the various plumbing fixtures.

less. Frequently experience and judgment will be required in the application of the tables.

Having determined the number of fixture units in the building under consideration, it is possible to determine the size of meter required by referring to either Fig. 1 or 2, depending on the number of fixture units. Again the judgment of the superintendent is required, especially if the available water pressure is low. He must decide the permissible head loss of the meter,

TABLE 3  
*Flush Valve Closets*

Size of Pipe—in.		Pressure in Main psi				Max. Length of Service ft
Service	House Supply and Branches	30-45	45-60	60-75	75-90	
1	1	—	13	25	35	75
		—	—	16	23	100
		—	—	11	17	125
1	1 $\frac{1}{4}$	10	33	55	60	75
		—	19	34	50	125
		—	12	24	35	175
1 $\frac{1}{2}$	1 $\frac{1}{4}$	25	57	96	140	75
		11	29	47	70	125
		—	19	31	45	175
1 $\frac{1}{2}$	1 $\frac{1}{2}$	55	125	205	260	75
		31	72	120	170	125
		21	49	84	118	175

After determining the total number of fixture units in any house or building and ascertaining the available water pressure and the length of the house pipe, the size of the required service and house pipe can be determined by means of Table 2 or 3. Table 2 should be used for ordinary types of plumbing fixtures, and Table 3 for flush-valve toilet installations.

It must be borne in mind that Tables 2 and 3 apply to average conditions and structures having 300 fixture units or

which in turn, determines its capacity. The superintendent should not penalize a consumer by the installation of an oversize meter in order to cut down the head loss. The low water pressure is not the fault of the consumer. The problem can usually be solved by installing an oversize service, thereby reducing the head loss in the service itself.

Thus, for structures not yet erected, the water supply problem lends itself to easy solution. But completed struc-

TABLE 4  
*Equivalent Pipe Lengths in Feet*

Diameter of Fittings in.	Equivalent Pipe Length—ft							
	90° Std. Ell	45° Std. Ell	90° Side Tee	Coupling Straight Tee	Type Valve			
					Gate	Globe	Angle	
$\frac{1}{2}$	2	1.2	3	0.6	0.4	15	8	23
$\frac{3}{4}$	2.5	1.5	4	0.8	0.5	20	12	30
1	3	1.8	5	0.9	0.6	25	15	38
$1\frac{1}{4}$	4	2.4	6	1.2	0.8	35	18	53
$1\frac{1}{2}$	5	3	7	1.5	1.0	45	22	68
2	7	4	10	2.0	1.3	55	28	83

tures, homes and buildings, new or old, probably constitute the major problem. For these, the San Francisco Water Dept. has set up the following inspection and testing program:

1. As soon as a poor-pressure complaint is received, an inspection of the situation is made. The actual water pressure is determined at the premises; the meter is observed for its freedom of operation; the meter is disconnected from the house pipe and the discharge into atmosphere through the service and meter is determined; and an inspection of the building is made to determine the number and type of plumbing fixtures, the size and length of existing house pipe, and the size and type of shutoff valve.

2. The results of the inspection are recorded on a form which is provided, and this form is returned to the proper office for an analysis and recommendation.

3. The findings and recommendations are given to the customer by letter.

For shutoff valves the San Francisco ordinance requires: "All valves used as main shutoff valves on a cold water

supply pipe shall be gate valves or full-opening cocks or stops." Table 4 (not included in the ordinance) indicates the reason for including this specification in the ordinance (3).

#### Ordinance in Practice

Consider a home where the following facts are ascertained:

1. Number of fixture units	33
2. Toilets of flush valve type	
3. Length of house pipe	60 ft
4. Size of house pipe	$\frac{1}{2}$ in.
5. Shutoff valve (globe type)	$\frac{1}{2}$ in.
6. Water pressure	50 psi
7. Existing service	$\frac{3}{4}$ in.
8. Length of service	10 ft
9. Existing meter	$\frac{5}{8}$ in.

The number of fixture units was determined from the number and type of plumbing fixtures in the building, using Table 1. It should be noted that the toilets are of the flush valve type and, consequently, Table 3 should be used for determining the size of service and house pipe. According to Table 3, the service should have been 1 in. and the house pipe  $1\frac{1}{2}$  in. Figure 1 indicates that the rate of maximum demand is 45 gpm and, hence, according to

San Francisco Water Dept. standards, a 1-in. meter will be required.

This example illustrates how wrong everybody can be—the water company as well as the builder—but the main responsibility rests with the builder. The water company had no advance information on the type of building which was to be erected, and could only assume that an average home would be built. The builder, however,

the existing  $\frac{3}{4}$ -in. service with a 1-in., and the  $\frac{5}{8}$ -in. meter with a 1-in., as required, but not until the owner had enlarged his house pipe as recommended. The owner's attention would also be directed to his shutoff valve and he would be advised that the new shutoff valve must be of the gate type instead of the globe type he now has, if he wants an adequate water supply in his building.

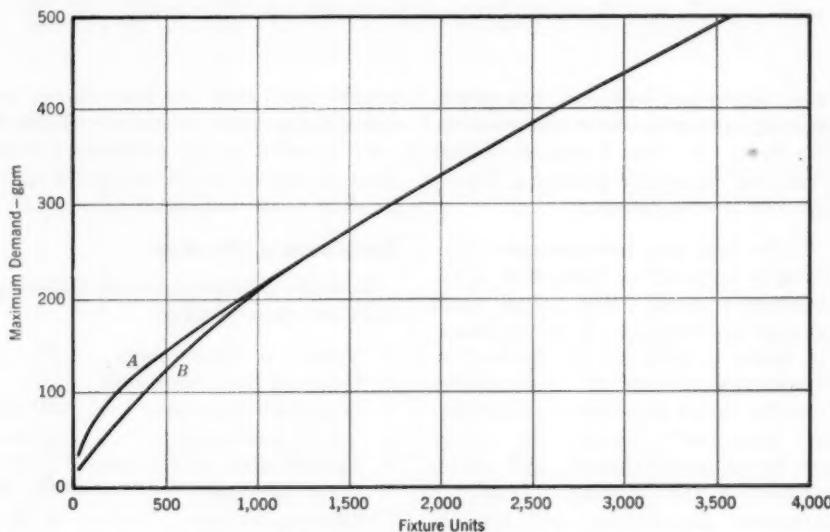


Fig. 1. Determination of Maximum Demand From Fixture Units

Curve A represents a flush valve system and Curve B a flush tank system.

probably knew the size and type of home he intended to build, but was not required to inform the water company.

With the passage of the ordinance in San Francisco regulating the size of services, meters, and house pipe, such a situation should never occur, but if a similar situation develops, it will be a simple matter to place the responsibility.

In the example given above, the San Francisco Water Dept. would replace

It should not be assumed that the responsibility of the water company ceases if the records show that the size of service and meter, as installed, is that required by the design, and that any complaint of "poor pressure" must, therefore, of necessity be the responsibility of the owner.

An actual incident which occurred in San Francisco illustrates this point. The records showed that the service was  $\frac{3}{4}$  in. with a  $\frac{5}{8}$ -in. meter. The

pressure in the street was 41 psi and there were six fixture units in the building. According to Table 2, the required service is  $\frac{3}{4}$  in., the same as that installed. A test of the service and meter gave only 9 gpm. It was obvious that something was wrong with the service. A new service was ordered at no expense to the owner as this situation was the responsibility of the water company. If the service was

was determined that the only means of overcoming the difficulty was to replace the old service with a new one.

In another incident the number of fixture units was 21, the size of service was  $\frac{3}{4}$  in. with a  $\frac{1}{2}$ -in. meter, the water pressure was 55 psi, and the house pipe consisted of 80 ft of  $\frac{3}{4}$ -in. pipe with a globe type shutoff valve. According to Table 2, the size of the service should be  $\frac{3}{4}$  in., the house pipe

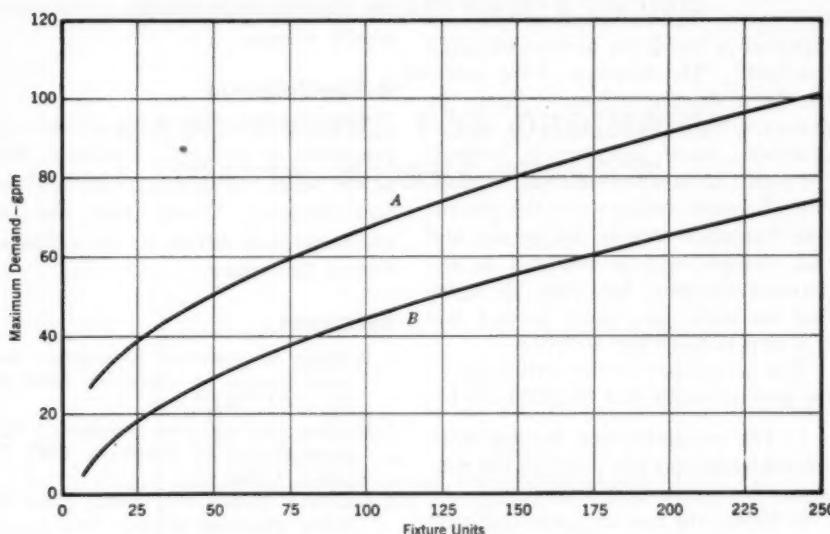


Fig. 2. Determination of Maximum Demand From Fixture Units

Curve A represents a flush valve system and Curve B a flush tank system.

adequate when first installed, what caused it to become inadequate? Examination of many inadequate services has indicated that incrustation on the inside surface was the cause. Many of the elbows and fittings were so badly coated with scale that only a small opening remained. Attempts were made to remove the scale by blowing and surging the service with compressed air without results, and it

should be 1 in. with a gate type shutoff valve, and, according to Fig. 1, the size of the meter should be  $\frac{1}{2}$  in.

A test of the service and meter discharging into atmosphere gave a flow of 22.5 gpm, which is more than adequate. Thus, the solution required change of house pipe only, and the consumer was so informed.

Many other similar incidents could be cited as well as incidents in which

both the service and house pipe were at fault. Incidents could also be cited in which, as a result of the remodeling of a building, many plumbing fixtures were added, but the size of service, meter, and house pipe remained the same as first installed, resulting in poor pressure complaints.

The method described for the determination of services, meters, and house pipe has been in operation by the San Francisco Water Dept. for more than two years. Not one incident has been reported in which the method of sizing has failed. The response of the public has been most gratifying. Even the plumbing trade, particularly the master plumbers, have accepted it without complaint, as have the builders. Everyone, of course, realizes that the present San Francisco code is not perfect and that changes will be required as experience dictates, but they all agree that the code was badly needed and is a step in the right direction.

The acceptance of the ordinance by the general public may be attributed to:

1. The inspection and findings with recommendations are given to the consumer by means of a letter.

2. When the test indicates that part of the fault of poor water supply is

due to the inadequacy of the service, the San Francisco Water Dept. notifies the consumer that the service will be renewed at no expense to him. He is also told not to change his house pipe until after the service has been installed, and then only if he is still dissatisfied with the water supply.

3. Advantage is taken of every opportunity to appear before the various improvement clubs in order to explain the features and problems of the water supply system.

#### Acknowledgment

The author wishes to express his appreciation to Oscar\*G. Goldman, Superintendent of City Distribution of the San Francisco Water Dept., for his assistance and advice in the preparation of this paper.

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**AWWA C500-52T**

(Formerly 7F.1)

**American Water Works Association**

***Tentative***

**STANDARD SPECIFICATIONS**

***for***

**GATE VALVES FOR ORDINARY  
WATER WORKS SERVICE**

These "Specifications for Gate Valves for Ordinary Water Works Service" are based upon the best known experience and are intended for use under normal conditions. They are not designed for unqualified use under all conditions and the advisability of their use for any installation must be subjected to review by the engineer responsible.

Approved by the AWWA Board of Directors as "Tentative" May 9, 1952, to be effective Jan. 1, 1953 (Sec. 17 and 18 effective June 1, 1953)

**American Water Works Association  
Incorporated**

**521 Fifth Avenue, New York 17, N.Y.**

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AWWA specifications for gate valves were originally adopted June 24, 1913, and modified June 9, 1916. A later revision was approved January 22, 1937, and published as Tentative in the March 1937 JOURNAL. After further revisions, it was adopted as Standard on April 29, 1938, approved by the New England Water Works Assn. on February 16, 1939, and published in the March 1939 JOURNAL. The present version was approved May 9, 1952, effective as a basis for purchase January 1, 1953 (except for Sec. 17 and 18, effective June 1, 1953).

**Tentative Standard Specifications for  
Gate Valves for Ordinary Water Works Service**

**Introduction**

These specifications have been developed by an AWWA committee with NEWWA representation. They include, directly or by reference, stipulations concerning materials and are intended to assist purchasers in obtain-

ing gate valves suitable for ordinary water works service. The specifications provide dimensions for bell and flanged ends of valves and include all dimensional information that is essential to uniformity of production.

**Section 1—General**

**Sec. 1.1—Scope**

These specifications cover iron-body, bronze-mounted valves intended for ordinary water works service in approximately level setting on buried pipelines in municipal water distribution systems, and include: double-disc gate valves with nonrising stems (Fig. 1), having either parallel or inclined seats, and solid-wedge gate valves with nonrising stems (Fig. 2).

water of unusual corrosivity (pH less than 5); excessive water hammer; frequent operation, as in filter service; or operation in throttled position. Such conditions are beyond the intended scope of these specifications and require special consideration in matters of design and construction.

**Sec. 1.4—Information to Be Supplied by Purchaser; Supplementary Specifications**

1.4.1. In placing orders for valves to be manufactured in accordance with these specifications, purchasers should specify the following details:

1.4.2. Specification used—that is, AWWA C500.

1.4.3. Size of valve.

1.4.4. Quantity required.

1.4.5. Type of valve as specified under Sec. 1.1.

1.4.6. Whether records of tests are to be furnished as specified under Sec. 2.2.

1.4.7. Type of valve ends—bell or flanged as specified under Sec. 6.

1.4.8. Detailed description of end connections if not bell or flange, or if

**Sec. 1.2—Valve Pressure Ratings**

Valves shall be designed for operation at working water pressures not exceeding 175 psi for valve diameters of 3 to 12 in., inclusive, and 150 psi for valves from 16 to 48 in., inclusive. Operating pressures or sizes of valves which fall outside these limits are beyond the intended scope of these specifications and require special consideration in design and construction.

**Sec. 1.3—Conditions Not Covered**

These specifications are not intended to cover special conditions of installation or operation—such as built-in power drive; installation in vertical or steeply inclined lines; conveyance of

bell or flange dimensions are to be other than as specified in Sec. 6.

1.4.9. Class or outside diameter of pipe to be used with valves 30 in. or larger, as specified under Sec. 6.1.1.

1.4.10. Intended position of valve in line—that is, horizontal or vertical.

1.4.11. Solid bronze discs, if required, as specified under Sec. 7.2.1.

1.4.12. If desired, acceptance of O-ring stuffing box if manufacturer offers valves so designed (*see* footnote under Sec. 13.1).

1.4.13. Detailed description of wrench nuts, if not in accordance with Sec. 16.

1.4.14. Direction in which wrench nut shall turn to open—whether right (clockwise) or left (counter-clockwise).

1.4.15. Gears, if required, as specified under Sec. 17.

1.4.16. Cast-iron gears, if required, as specified under Sec. 17.2.1.

1.4.17. Whether gear cases are not to be provided, as specified under Sec. 18.

1.4.18. Position indicator, if required, as specified under Sec. 19.

1.4.19. By-pass, if required, as specified under Sec. 20. Unless otherwise specified, the position of the by-pass on the valve body shall be as shown in Fig. 3, Position A or B.

1.4.20. Spot-facing, if required, as specified under Sec. 22.2.1.

1.4.21. Special cast markings, if required, as specified under Sec. 24.

1.4.22. Manufacturer's certification of tests, if required, as stated under Sec. 26.2.

### Sec. 1.5—Data to Be Furnished by the Manufacturer

1.5.1. After purchase, the manufacturer shall, if requested, furnish catalog data, including illustrations, and a schedule of parts and the materials of which they are made, in sufficient detail to serve as a guide in the assembly and taking down of the valve, as well as in ordering repair parts.

1.5.2. When required, the manufacturer shall furnish a statement of the total net assembled weight for each size of valve.

1.5.3. When required, the manufacturer shall submit for approval by the purchaser one set of certified drawings, showing the principal dimensions, construction details, and materials used for all parts of the valve. All work shall be done and all valves shall be furnished in accordance with these certified drawings, after they have been approved by the purchaser.

## Section 2—Materials

### Sec. 2.1—General

All materials designated hereinafter, when used in valves produced under these specifications, shall conform to the specifications designated below for each material listed. When reference is made to American Standards Assn. (ASA), American Society for Testing Materials (ASTM), or other specifications, it is understood that the latest revision thereof shall apply.

### Sec. 2.2—Determination of Physical and Chemical Properties

2.2.1. The requirements of ASA, ASTM, or other standard specifications, to which reference is made elsewhere in this text, shall govern the physical and chemical characteristics of the valve components.

2.2.2. Whenever valve components are to be made in conformance with ASA, ASTM, or other specifications,

and these specifications include test requirements or testing procedures, such requirements or procedures shall be met by the valve manufacturer. The records of such tests shall, if required by purchaser, be made available to him.

### Sec. 2.3—Cast Iron

2.3.1. Cast iron shall conform to ASTM Specification A126.

### Sec. 2.4—Bronze \*

2.4.1. Grade I cast bronze shall conform to the properties of ASTM B62.

2.4.2. Grade II cast bronze shall conform to the properties of ASTM B132, Alloy A.

2.4.3. Grade III cast bronze shall conform to the properties of ASTM B132, Alloy B.

2.4.4. Grade IV rolled bronze shall conform to the properties of ASTM B21, Alloy A (one-half hard).

2.4.5. Grade V bronze shall be sufficiently malleable to conform to dovetailed grooves when peened or rolled, and shall have a minimum compressive strength, without deformation, of 4,000 psi.

### Sec. 2.5—Steel

2.5.1. Body bolts and nuts shall conform to ASTM A307, Grade B.

2.5.2. Carbon steel castings, when used, shall conform to ASTM A27 Grade U60-30.

### Sec. 2.6—Babbitt

2.6.1. Babbitt metal shall conform to ASTM B23.

## Section 3—General Design

### Sec. 3.1—Resistance to Stress

All parts of all valves shall be designed to withstand safely, without permanent distortion and without structural damage, both the stresses resulting from an internal test pressure of 300 psi and the combined stresses resulting from the full, internal, specified, service, working water pressure as specified under Sec. 1.2, when the gates or wedge moves across the seats, under full unbalanced working water pressure from the fully closed

position to the point of full opening; thence to complete closure.

### Sec. 3.2—Basis of Structural Design

All parts of valves, including body and bonnet, shall be so proportioned that it will be possible to apply sufficient torque to the stem, in the closing direction, with the valve closed and with the valve internally subjected to the working water pressure, to cause the stem to fail without causing permanent distortion of any part other than the stem.

### Sec. 3.3—Size of Waterway

With the valve open, an unobstructed waterway shall be afforded, the diameter of which is not less than the full nominal diameter of the valve, except that, if lugs are provided for inserting or removing the body-seat rings, they need not be cleaned out after the valve is assembled.

\* Grades II, III, and IV bronze must not be used in a system in which the water has been lime softened and is distributed at a high pH, as such water will remove zinc from the bronze. These materials are specified for valve stems, guide contacts for wedge gate valves, wedges for gate valves, etc. Alternate materials acceptable to the manufacturer and to the purchaser must be used with such waters.

## Section 4—Bodies and Bonnets

### Sec. 4.1—Design

4.1.1. It is recognized that some variations are unavoidable in the making of patterns and castings. In order to define what may be considered a reasonable degree of accuracy in shell thickness measurements, the following inspection limits shall be allowed:

4.1.2. Shell thickness measurements taken at points diametrically opposite each other shall, when added together and divided by two, equal or exceed the minimum metal thicknesses given in Table 1. Shell thicknesses at no point shall be more than  $12\frac{1}{2}$  per cent below the minimum metal thicknesses called for in Table 1, and no continuous area of deficient thickness shall exceed  $12\frac{1}{2}$  per cent of the superficial area of the casting.

4.1.3. All metal sections and ribbing shall be properly proportioned, and corners shall have well-rounded fillets, in accordance with the best foundry practice. In double-disk gate valves, the body and bonnet shall be designed to reduce the side clearance of the discs.

4.1.4. The valve body shall be machined and threaded for shoulder-seated (or bottom-seated) body-seat rings, with sufficient depth of thread and accuracy of seating surface to prevent leakage behind the body-seat rings.

4.1.5. The thrust-bearing recess and the stem opening in the bonnet shall be finished. In valves 16 in. in diameter and larger, the thrust-bearing recess shall be Grade I or II bronze-lined, and the stem opening shall be Grade I or II bronze-bushed.

4.1.6. In horizontal-stem valves 16 in. in diameter and larger, and in ver-

tical-stem valves 24 in. in diameter and larger, a pair of accurately matched dowel holes and tapered or round-end dowels shall be provided in the flanges of body and bonnets to aid in assem-

TABLE 1

### Minimum Thickness of Bodies and Bonnets

Valve Diameter in.	Minimum Thickness* in.
3	0.37 ( $\frac{1}{8}$ )
4	0.40 ( $\frac{5}{32}$ )
6	0.43 ( $\frac{7}{16}$ )
8	0.50 ( $\frac{1}{2}$ )
10	0.63 ( $\frac{3}{8}$ )
12	0.68 ( $\frac{11}{32}$ )
16	0.85 ( $\frac{3}{4}$ )
20	0.97 ( $\frac{13}{32}$ )
24	1.08 ( $1\frac{1}{4}$ )
30	1.39 ( $1\frac{13}{32}$ )
36	1.54 ( $1\frac{1}{2}$ )
42	1.58 ( $1\frac{13}{32}$ )
48	1.73 ( $1\frac{3}{4}$ )

\* The decimal value should be used when the two expressions are not exactly equivalent. The figures listed are taken from ASA A21.2 (AWWA C102), specification for cast-iron pit-cast pipe for water or other liquids. Thicknesses of valves up to and including the 36 in. are the same as those specified for Class 250 pit-cast pipe. Thicknesses of 42- and 48-in. valves are the same as those specified for Class 200 pit-cast pipe.

bling. Dowels shall be located at opposite ends of the flange, one near lateral center line, and other approximately 2 in. from lateral center line.

### Sec. 4.2—Material

Bodies and bonnets of valves 10 in. and larger in size shall be made of cast iron of not less than "Class B" material as specified in ASTM A126. Bodies and bonnets of valves less than 10 in. in size shall be made of cast iron of quality not less than Class A material specified in ASTM A126.

## Section 5—Bonnet Bolting

Body bolts and nuts shall conform to ASTM A307, Grade B. Bolts and

nuts shall be either cadmium-plated or zinc-coated (ASTM A123), or rust-

proofed by some other process (parkerizing, sherardizing, etc.), disclosed to, and acceptable to, the purchaser. Body

bolt studs shall conform to the threading and physical requirements of ASTM A307 Grade B.

## Section 6—Valve Ends

### Sec. 6.1—Ends for Bell-and-Spigot Pipe

6.1.1. Valves designed for installation with bell-and-spigot pipe shall be cast with bells on each end of the valve. The dimensions of the bells on valves up to and including 24 in. in diameter shall conform to those for Class C\* special castings, as required by AWWA C100. On valves 30 in. and larger in size, either the bell dimen-

sions, the class, or the outside diameter of the pipe to be used shall be specified by the purchaser.

### Sec. 6.2—Ends for Flanged Pipe

The end flanges of flanged gate valves shall conform in dimensions and drilling to the standard ASA B16.1 for cast-iron flanges and flanged fittings, Class 125, unless explicitly provided otherwise in the supplementary specifications.

## Section 7—Gates and Rings

### Sec. 7.1—Design

7.1.1. Cast-iron gates shall be fitted with separate rings in such a manner as to preclude loosening or leaking behind the seats, with cross section sufficiently stiff to resist accidental deformation in handling and assembly.

7.1.2. Gate rings shall be rolled, peened, or pressed into grooves machined in the discs, or fastened by some other method disclosed to, and acceptable to, the purchaser.

7.1.3. Finish cuts shall be taken over the gate rings after they have been fully secured in place.

7.1.4. The width of the face of the gate rings shall not be less than that

of the body-seat rings, and there shall be provided a sufficiently greater width to permit the gates to continue to seat tightly after allowing for reasonable wear of the faces of the rings, and of the various parts of the mechanism of the gate.

### Sec. 7.2—Material

7.2.1. Valve gates or wedges shall be made of cast-iron or Grade I bronze, at the manufacturer's option, unless bronze is explicitly required by the purchaser's supplementary specifications.

7.2.2. Gate rings shall be made of Grade V bronze.

## Section 8—Body-Seat Rings

### Sec. 8.1—Design

8.1.1. Body-seat rings shall be back-faced, the threads accurately cut, and

the rings shall be screwed into machined seats in the body. They shall be made with cross section sufficiently stiff to resist accidental deformation in handling and assembly.

8.1.2. The width of body-seat ring shall be sufficient to result in a bearing pressure of the gate on the body-seat ring of not more than 2,000 psi under the hydrostatic pressure of 300 psi.

* AWWA C100 Class C Bell Diameter	
Size of Pipe	ID of Bell
4	5.80
6	7.90
8	10.10
10	12.20
12	14.30
16	18.80
20	23.06
24	27.32

The thickness of the body-seat ring shall be not less than 20 per cent of the width of the face as calculated from the above requirement.

### Sec. 8.2—Material

Body-seat rings shall be made of Grade I bronze.

## Section 9—Wedging Device

### Sec. 9.1—Design

Gate valves of the double-disc type shall be equipped with a free and positive-operating internal wedging device, simple and rugged in design, which, in closing the valve, will operate (when discs are opposite the ports) to press the discs firmly against the body seats and release them therefrom before the valve starts to open.

### Sec. 9.2—Material

9.2.1. Bronze used for wedges shall be Grade I, II, or III.

## Section 10—Guides (Wedge-Gate Valves)

In solid-wedge gate valves, tongue-and-groove guides shall be provided on the sides of the gate and in the body to keep the gate centered between the seats throughout its full length of travel. In valves 16 in. in diameter and larger, bearing of gate on guides shall

have length equal to at least 50 per cent of the port diameter of the valves, and the grooves in the gate shall be Grade I, II, III, or IV bronze-faced to bear against the guides in the body. Guide contacts shall be Grade II, III, or IV bronze to bronze.

## Section 11—Rollers and Tracks for Horizontal Valves

### Sec. 11.1—Double-Disc Valves

11.1.1. Gate valves of double-disc type, 16 in. in diameter and larger, designed to lie horizontally in a horizontal pipeline, shall be equipped with solid (Grade I or IV) bronze or hard babbitt tracks securely fastened in body and bonnet, carrying the weight of the gates throughout their entire length of travel on rollers. Babbitt metal for tracks shall conform to ASTM B23, Grade 3.

11.1.2. In double-disc gate valves of the "rolling-disc" type, the discs will serve as rollers.

11.1.3. In double-disc valves of other than the rolling-disc type, the discs shall be carried on solid (Grade I, II, III, or IV) bronze rollers securely attached to them.

### Sec. 11.2—Wedge-Gate Valves

In gate valves of the solid-wedge type, 16 in. in diameter and larger, designed to lie horizontally in a horizontal pipeline, the tongue-and-groove gate guides shall be modified with rollers or shoes to carry the weight of the wedge throughout its entire length of travel on

solid (Grade I or IV) bronze or hard babbitt tracks securely fastened in the body and bonnett. Babbitt metal shall conform to ASTM B23, Grade 3.

### Sec. 11.3—Scrapers

In all valves in which rollers and

tracks are used, bronze scrapers (Grade I, II, III, or IV) shall be provided to traverse the tracks ahead of the rollers in both directions of travel to remove any foreign matter which may have accumulated on the track.

## Section 12—Stems and Stem Nuts

### Sec. 12.1—Design

12.1.1. All stem collars shall be made integral with stems.

12.1.2. The threads of stems and stem nuts (disc bushings) shall be of the square, Acme, modified Acme or one-half V type, with a sufficient number of cuts to avoid straining the metal.

12.1.5. Stems in valves up to and including 20 in. in diameter shall have a lead of not more than  $\frac{1}{3}$  in. Stems in valves 24 in. and larger shall have a lead of not more than  $\frac{1}{2}$  in.

### Sec. 12.2—Material

12.2.1. Valve stems shall be cast, forged, or rolled bronze.

TABLE 2  
*Minimum Diameter of Stem*

Diameter of Valve in.	Min. Diam. of Stem at Base of Thread in.
3	0.8594
4	0.8594
6	1.000
8	1.000
10	1.125
12	1.188
16	1.438
20	1.750
24	1.969
30	2.188
36	2.50
42	2.75
48	3.50

12.1.3. Stems shall be turned and threaded straight and true, and shall work true and smooth and in perfect line throughout the lift of opening and thrust of closing the valve.

12.1.4. The diameters of stems at the base of the thread shall be not less than those shown in Table 2.

TABLE 3  
*Physical Characteristics for Manganese Bronze\**

	Minimum Tensile Strength psi	Minimum Yield Strength psi	Minimum Elonga-tion in 2 in. per cent
Valve sizes up to and including 24 in.	60,000	20,000	15
Valve sizes 30 in. and larger	80,000	32,000	15

\* For use in forged and rolled stems.

12.2.2. Bronze for cast stems shall be Grade II or III for valve sizes 24 in. and smaller, and Grade III for valve sizes 30 in. and larger.

Bronze for forged and rolled stems shall be manganese bronze having the physical characteristics given in Table 3.

12.2.3. Stem nuts shall be Grade I, II, or III bronze.

## Section 13—Stuffing Boxes

### Sec. 13.1—Design

13.1.1. Design of the stuffing box shall be such that the valve can be packed under pressure when in the fully open position.\*

13.1.2. The stem opening, thrust-bearing recess, and bonnet face of the stuffing box shall be machined. In valves 16 in. in diameter and larger, both the stem opening and thrust-bearing recess shall be Grade I, bronze-bushed.

13.1.3. Stuffing boxes shall have a depth not less than the diameter of the valve stem. The internal diameter shall

be large enough to contain adequate packing to prevent leakage around the stem.

### Sec. 13.2—Material

13.2.1. The stuffing box shall be made of cast iron.

13.2.2. Bronze for the stem-collar thrust bushings shall be Grade I.

13.2.3. Stuffing box bolts and nuts shall conform to ASTM A307, Grade B. They shall be rust-proofed as is required for body bolts and nuts in Sec. 5.

## Section 14—Packing

### Sec. 14.1—Material

Stuffing box packing shall be made of asbestos conforming to Navy Department Specification 33-P-26-b, Type A, or flax packing conforming to Federal Specification HH-P-106c.

Hemp packing shall not be used.

### Sec. 14.2—Installation

Stuffing boxes shall be properly packed and ready for service when valves are delivered to the purchaser.

## Section 15—Glands and Gland Bolts and Nuts

### Sec. 15.1—Design

15.1.1. The gland assembly shall be of solid, solid-bushed, or two-piece design.

15.1.2. Gland flanges (followers) may be formed as a flanged end on the gland, or as a separate part.

### Sec. 15.2—Material

15.2.1. Glands for valves of sizes 12 in. and smaller shall be made of Grade I, II, III, IV, or ASTM B124 bronze. Glands for valves of sizes larger than 12 in. in diameter may be made of iron

with bushings of Grade I, II, III, IV, or ASTM B124 bronze. Glands which are either cadmium-plated or zinc-coated (ASTM A123) or rust-proofed by some other process, such as parkerizing or sherardizing, disclosed to, and acceptable to the purchaser, may be furnished.

15.2.2. If a gland flange (follower) is used, it may be made of the same material as the gland.

15.2.3. Gland bolts shall be made either of Grade II or IV bronze or rust-proofed steel according to Sec. 5. Gland bolt nuts shall be made of Grade II, III, or IV bronze.

\* Some manufacturers offer a valve provided with an O-ring stuffing box. The purchaser may accept this design, if he desires (see Sec. 1.4.12).

## Section 16—Wrench Nuts

### Sec. 16.1—Design

16.1.1. Wrench nuts shall be fitted to the top of the valve stem, and secured in position by nut, pin, or key.

16.1.2. Unless otherwise explicitly required by the purchaser's supplementary specifications, the wrench nuts shall be  $1\frac{5}{8}$  in. square at the top, 2 in. square at the base, and  $1\frac{1}{2}$  in. high. Nuts shall have a flanged base upon which shall be cast an arrow at least 2 in. long showing the direction of opening, and the word "OPEN," in

$\frac{1}{2}$ -in. or larger letters, shall be cast on the nut to indicate clearly the direction to turn the wrench when opening the valve.

16.1.3. The flanged base of the nut may be shaped or cut away to permit access from the ground surface to the packing gland bolts with an extension socket wrench.

### Sec. 16.2—Material

Wrench nuts shall be made of cast iron.

## Section 17—Gearing

### Sec. 17.1—Design

17.1.1. Gears shall be accurately formed and smooth-running, with bronze spindles running in bronze, or

with babbitt-lined bearings. Gear teeth shall be machine cut.

17.1.2. Gear ratios shall not be less than those shown in Table 4.

### Sec. 17.2—Material

17.2.1. Geared valves shall be equipped with cut-tooth steel gears, unless cut-tooth cast-iron gears are explicitly required by the purchaser's supplementary specifications. Pinions with cast-iron gears shall be steel. Material for steel gears shall conform to the physical requirements of Specifications ASTM A27, Grade U-60-30.

17.2.2. Babbitt lining for bearings shall conform to ASTM B23, Grade 8.

## Section 18—Gear Cases

When geared valves are furnished, enclosed gear cases are required unless definitely excluded by the purchaser's supplementary specifications. Two types may be furnished—the "extended type" or the "totally enclosed type." The extended type shall be attached to

the bonnet of the valve in such manner as to permit repacking of the stuffing box of the valve without disassembly. The totally enclosed type shall be attached to the bonnet to enclose both stuffing box and gearing.

## Section 19—Indicators

When required by purchaser's supplementary specifications, geared valves

shall be equipped with indicators to show the position of the gate in rela-

tion to the ports. The indicator mechanism shall be all bronze, enclosed in a dirt-proof cast-iron case, and mounted

in such position that the indicator can be easily seen by the man operating the valve.

## Section 20—By-passes

By-passes, when required by purchaser's supplementary specifications, shall be of the sizes shown in Table 5 and shall be located in one of the positions indicated in Fig. 3. By-pass valves shall be the same size as the by-pass and shall conform to the requirement of these specifications for the specific valve size used.

TABLE 5

## Size Requirements of By-passes

Valve Diameter in.	By-pass Diameter in.
16-20	3
24-30	4
36-42	6
48	8

## Section 21—Gaskets

### Sec. 21.1—Design

Gaskets shall be full-cut, with holes to pass bolts, or cut to fit inside of bolts, and shall be used on all flanged joints intended to be watertight.

### Sec. 21.2—Material

Gasket material shall be either sheet asbestos, a rubber composition, or paper free from corrosive ingredients, either alkaline or acid.

## Section 22—Workmanship

### Sec. 22.1—General

All workmanship employed in the fabrication and assembly of valves covered by this specification shall be first-class in every respect. Valve parts shall be designed, and manufacturing tolerances set, to provide interchangeability in the products of any one manufacturer between units of the same size and type, except the individual fit of the wedge in the body. When assembled, valves manufactured in accordance with these specifications

shall be well-fitted, smooth-running, and watertight.

### Sec. 22.2—Details

22.2.1. Unless spot facing is required by supplementary specifications, the bolt holes of the end flanges shall not be spot-faced, except as specified in ASA Standard B16.1. (See Note at end.)

22.2.2. All castings shall be clean and sound, without defects which will impair their service. No plugging, welding, or repairing of such defects will be allowed.

## Section 23—Painting

An asphalt varnish made to comply with Federal Specification TT-V-51a or Army & Navy Specification JAN-P-450 shall be applied to the ferrous part of the valves, except finished or

bearing surfaces. Surfaces shall be clean, dry, and free from grease before painting. Two coats shall be applied both to the inside and outside ferrous metal.

## Section 24—Markings

Markings shall be cast on the bonnet or body of each valve showing the manufacturer's name or mark, the year the valve casting was made, the size of the valve, and the designation of working water pressure (150 W or

175 W). Special markings in addition to these can be supplied, when specified by supplementary requirements, upon agreement between purchaser and manufacturer.

## Section 25—Testing

### Sec. 25.1—Performance Tests

After completion each gate valve shall be tested at the shop for performance in operation, and for watertightness and resistance to distortion under internal pressure. Each valve shall be operated in the position that it will assume in service and for the full length of gate travel in both directions, to demonstrate the free and perfect functioning of all parts in the intended manner. Any defects of workmanship shall be corrected and the test repeated until satisfactory performance is demonstrated.

### Sec. 25.2—Hydrostatic Tests

25.2.1. Each 3- to 12-in. valve, inclusive, shall be subjected to hydrostatic test under pressures of both 300 and 175 psi. Each 16- to 48-in. valve, inclusive, shall be subjected to test

pressures of both 300 and 150 psi. The tests shall be conducted in the following manner:

25.2.2. For double-disc gate valves, the hydrostatic pressure shall be applied inside the bonnet with gates closed.

25.2.3. For solid-wedge gate valves, the 150- or 175-psi pressure (as required in 25.2.1) shall be applied, through bulkheads, alternately to each side of the closed gate, with the opposite side open for inspection; the 300-psi pressure shall be applied with both ends bulkheaded and the gate open.

25.2.4. Under the 150 or 175 psi test (as required in 25.2.1), all joints and seats shall be perfectly watertight. Under the 300-psi test, there shall be no leakage through the metal, nor through the flanged joints, nor shall any cast part be permanently deformed.

## Section 26—Inspection and Rejection

### Sec. 26.1—Purchaser's Inspector

All work under these specifications shall be subject to inspection and approval by the purchaser's duly authorized engineer or inspector, who shall at all times have access to all places of manufacture where materials are being produced or fabricated or tests are being conducted, and who shall be accorded full facilities for inspection and observation of tests. Any gate valve or part which he may condemn as not conforming to the requirements of these

specifications shall be made satisfactory or shall be rejected and replaced.

### Sec. 26.2—Manufacturer's Certification

If the purchaser has no inspector at the plant, the manufacturer shall, if requested at the time the order is placed, certify that the required tests on the various materials and on the completed valve have been made, and that the results of all tests conform to the requirements of these specifications.

## Section 27—Preparation for Shipment

### Sec. 27.1—General

Valves shall be complete in all details when shipped. The manufacturer shall use care in preparing them for shipment so that no damage due to the manufacturer's negligence will occur in handling or in transit. Valves must be

drained and completely closed before shipment.

### Sec. 27.2—Large Valves

Valves 24 in. and larger in diameter shall be securely bolted or otherwise fastened to skids in such manner that they may be safely unloaded with a crane.

## Notes

The valve illustrations (Fig. 1-3) point out some of the stipulations of these specifications, but show also some variations of commercial design on which the purchaser may exercise a choice. The purchaser should state all his requirements at the time of purchase. No one manufacturer will be prepared to furnish valves in all applicable variations.

Requirements for spot-facing, as given in Sec. 22.2.1, suggest reference to Introductory Note 12 from American Standard ASA B16.1:

*Spot Facing. Flanges.* The bolt holes of these cast-iron flanges need not be spot-faced for ordinary service except as follows: in sizes 12 in. and smaller when rough flanges, after facing, are oversize more than  $\frac{1}{8}$  in. in thickness, they shall be spot-faced to the specified thickness of flange (minimum) with a plus tolerance of  $\frac{1}{16}$  in. In sizes 14 to 24 in., inclusive, when

rough flanges, after facing, are oversize more than  $\frac{1}{8}$  in. in thickness, they shall be spot-faced to the specified thickness of flange (minimum) with a plus tolerance of  $\frac{1}{16}$  in. In sizes 30 in. and larger when rough flanges, after facing, are oversize more than  $\frac{1}{4}$  in. in thickness, they shall be spot-faced to the specified thickness of flange (minimum) with a plus tolerance of  $\frac{1}{16}$  in.

*Spot-Facing. Fittings.* The bolt holes of the flanges on these cast-iron fittings need not be spot-faced on sizes smaller than 18 in. for ordinary service, except as required for oversize thickness of flanges as indicated above. The bolt holes of all flanges on fittings 18 to 24 in., inclusive, shall be spot-faced to the specified thickness of the flange (minimum) with a plus tolerance of  $\frac{1}{16}$  in. The bolt holes of all flanges on fittings 30 to 48 in., inclusive, shall be spot-faced to the specified thickness of the flange (minimum) with a plus tolerance of  $\frac{1}{16}$  in.

Where spot-facing of flanges and fittings is necessary, the spot-facing diameter shall be in accordance with MSS Standard Practice SP-9-1947.

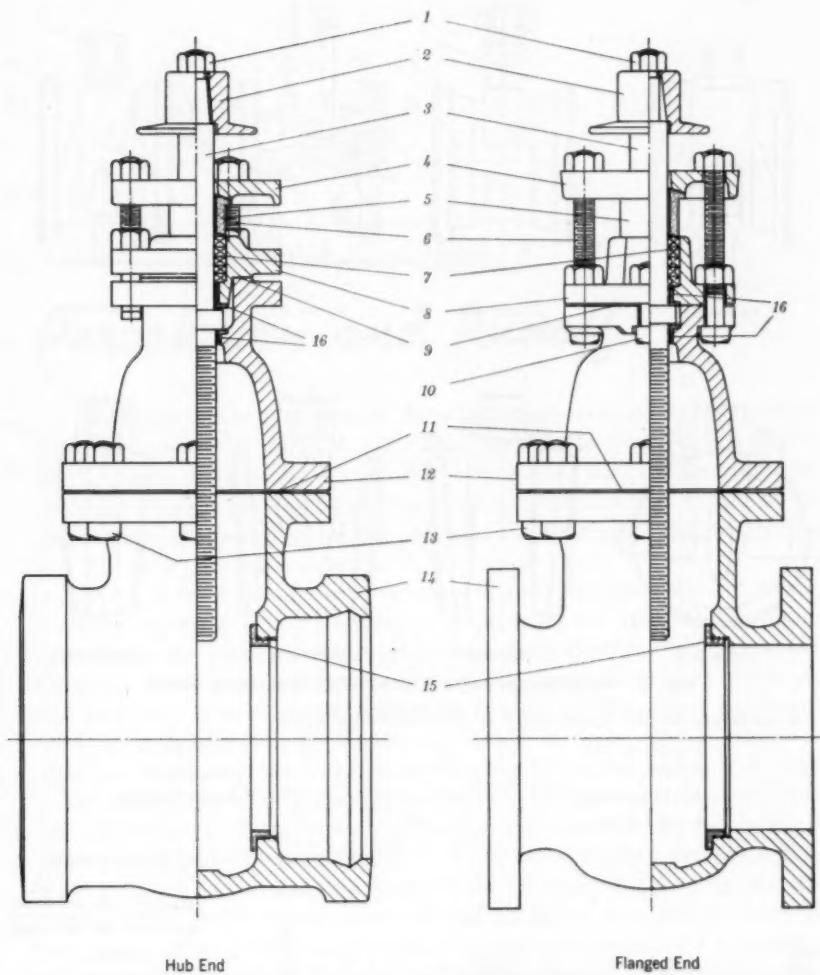


Fig. 1. Double-Disc Gate Valves With Nonrising Stems

The numbers on the figure refer to the following parts:

1—Nut for wrench nut	10—Stuffing box bolts and nuts or studs and nuts
2—Wrench nut	11—Bonnet gasket
3—Stem	12—Bonnet
4—Gland flange (or follower)	13—Bolts, bolt-studs, and nuts for bonnet
5—Gland	14—Body
6—Gland bolts and nuts	15—Seat ring (body)
7—Stem packing	16—Stem collar thrust bushing
8—Stuffing box	
9—Stuffing box gasket	

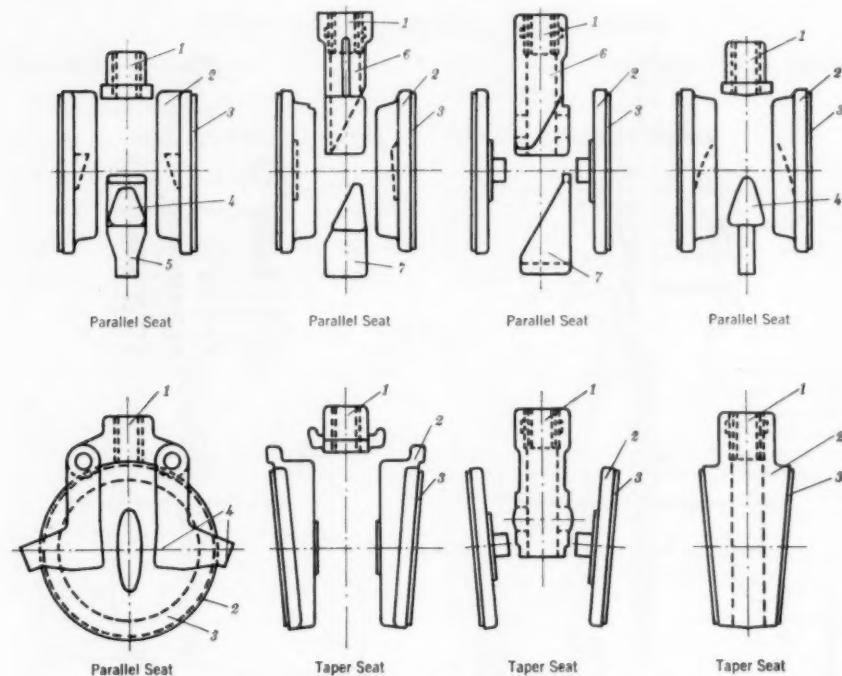


Fig. 2. Solid-Wedge Gate Valves With Nonrising Stems

The numbers on the figure refer to the following parts:

- 1—Stem nut
- 2—Disc
- 3—Disc ring
- 4—Wedge

- 5—Wedge hook
- 6—Top wedge
- 7—Bottom wedge

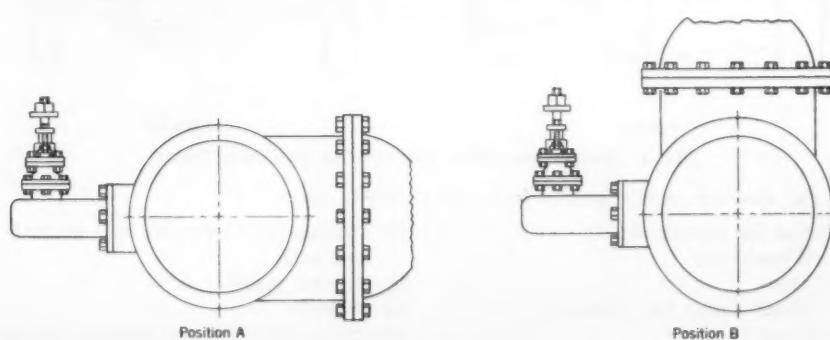
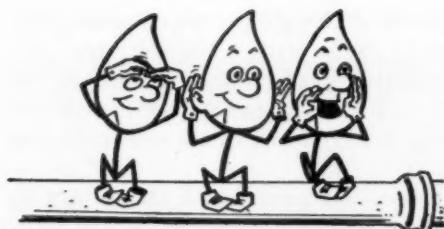


Fig. 3. Location of By-pass Valve

In Position A the main valve is installed horizontally, and in Position B it is installed vertically.



## *Percolation and Runoff*

**Sloshing its weight around** more than ever these days, water keeps splashing into the public eye—eventually, perhaps, to wash out the cinder that prevents the public from seeing the vital need for water works—for more and more, bigger and better, and, oh yes, costlier and costlier water works. Especially helpful of late has been the timeliness, the placeliness, and the variety of the ensloshment.

What more dramatic slosh, for instance, than the one which cut off air conditioning at the White House on a 90-plus day last July, when a 36-in. main break shut down all water supply not only to Harry's place, but to the Capitol, a dozen major hotels, several hospitals, many government buildings, and hundreds of homes and apartment houses? What more significant slosh than the one which stopped production in three defense plants at Wichita, Kan., in June, when three 48-in. main breaks within four days caused the layoff of 50,000 aircraft workers and left the city's 170,000 people hot and thirsty? What more frightening slosh than the one which left a large part of July-dry Binghamton, N.Y., virtually without fire protection, when a 20-in. main break two blocks from the main pumping station left most of city's 24,000 homes waterless, had all the off-duty firemen back at their posts, all the retired fire equipment at the ready, and all the population aware of the danger of conflagration? And what more forthright slosh than the one which caused the board of health of Livingston, N.J., to propose a temporary ban on home building in the community because of the health menace involved in the system's inability to maintain pressure to its high service areas for several hours during the day.

But all the slosh hasn't been calamity bound either. In industry, particularly, the weight of water is being felt these days quite apart from disaster. Small wonder too, when, as the National Production Authority recently pointed out, it requires 1,050,000 gal of water to produce 1,000 barrels of aviation gasoline, 15,800,000 gal to produce 1,000 barrels of synthetic gasoline; 80,000-110,000 gal per ton of rolled steel, 24,000-34,000

*(Continued on page 2)*

(Continued from page 1)

gal per ton of refined beet sugar, 64,000-70,000 gal per ton of sulfate pulping, and 180,000-200,000 gal per ton of viscose rayon. Nor is it mere quantity that has begun to count with industry. "Water With a Southern Accent" is what Schenley Distributors, Inc., are bragging about putting into their whiskeys, and it is "Waukesha Water" to which the makers of Fox Head beer make *their* public bow.

Certainly if a mere drip of water can wear away a stone, all this sloshing should some day wear away the strings of the community's purse as far as its water department is concerned. That'll be the day!

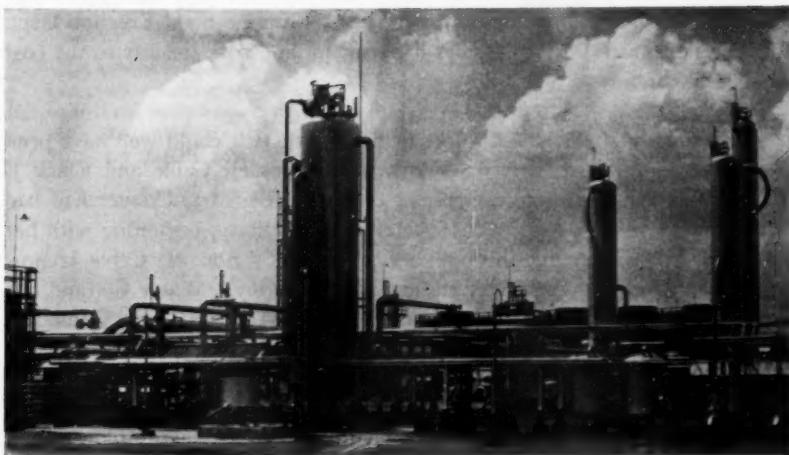
**Slosh on a nation-wide scale** can feature the week of October 5-11 if we play our cards right, for what better emphasis on the importance of public water supply than a reminder of its role in fire protection? The week, of course, is Fire Prevention Week, when public attention will be focused on the fact that fire daily attacks 849 homes, 79 stores, 88 factories, 9 churches, 8 schools, 4 theatres, and 4 hospitals. Water works men will be missing a real opportunity if they fail to point out how vital that makes a ready-to-serve supply of water at least 379,965 times per year. Besides it's in your own interest to help in fire prevention—think of all the water (unpaid for) it will save.

**"Merit Awards"** for the quality of their 1951 annual reports were earned by seven water works companies in the annual competition sponsored by *Financial World*, investment and business weekly. Thus made eligible for the final judging, in which the "Best of Industry" award will be bestowed, are the American Water Works Co., Hackensack Water Co., Jamaica Water Supply Co., New York Water Service Co., Scranton-Spring Brook Water Service Co., Southern California Water Co., and Washington Water Power Co. Last year's "Best of Industry" plaque had been won by the Southern California organization.

**Safest plant** in the entire country is the distinction accorded Chain Belt Company's Plant 3 in its Construction Machinery Div. The award was earned as the result of a contest sponsored by the National Safety Council. From May 1950 to December 1951, no disabling injuries marred the performance of 1,297,204 man-hours of work at the plant. There were only two "lost-time" accidents at the plant since January 1949.

**W. H. Wisely**, executive secretary-editor of the Federation of Sewage & Industrial Wastes Associations, has been appointed by Governor Adlai Stevenson to represent Illinois in the Ohio River Valley Water Sanitation Commission. He succeeds Jesse Woltmann, Bloomington, Ill., consultant, who died last May.

(Continued on page 4)



NORTH COWDEN GASOLINE PLANT near Odessa, Texas, operated by Stanolind Oil and Gas Company. Here Worthington Water Softeners protect boilers from scale-forming deposits.

## Worthington softeners protect this plant's boilers 10 ways

In this case, it's a hot-process softener to remove scale-forming deposits from boiler feedwater.

Let's examine this gasoline plant installation and see how it gives boilers "maximum" protection:

1. Feed water is softened by a hot-lime soda system.
2. Selective deaeration for operation on make-up only, condensate only, or both.
3. Non-scaling direct-contact vent condenser heats and vents treated make-up.
4. Tubular vent condenser vents condensate.
5. Oxygen contamination of feedwater avoided by last-step deaeration.
6. Stainless steel deaerating elements.

7. Uniform and efficient deaeration during wide load swings.

8. Filter backwashing with clean, hot, chemically inert water without velocity change through the softening zone.

9. Proportionate sludge removal.

10. Uniformly proportionate chemical feed.

Before you buy, investigate Worthington Water Softening Systems thoroughly. Tell us the service conditions, and get our recommendations in terms of dollars and benefits. Write Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Water Treating Section, Harrison, New Jersey.

13.4



(Continued from page 2)

**Thomas Cruthers**, vice-president of Worthington Corp. since 1936, died at his home on July 27, at the age of 68. He had been with Worthington since 1907, when he took charge of the Gas Engine Field Erection Dept. In 1925 he transferred to the sales department, and rose steadily to the post he held at the time of his death.

**First lady** of the water works field is a title that could well have been bestowed upon the mother of AWWA members H. Cable and Clark J. Cramer. When she died last July at the age of 84, Mrs. Cramer had had a hand in more than 200 years of water works activity, beginning with her husband and continuing through her grandsons. Son H. Cable is now manager of the Catlettsburg, Kenova & Ceredo (Ky.) Water Co. and son Clark J. chief engineer of the Lexington (Ky.) Water Co. A full life, more than 100 per cent dedicated to water.

**A \$2,000,000 survey** of water resources in Texas is being projected by Texas A&M College to help solve such problems as where to locate new industrial plants. Results of the long-term study will be made available to all those interested.

(Continued on page 6)

**TC**  
TENNESSEE CORPORATION

**SODIUM  
FLUOSILICATE**  
(Silico Fluoride)

**Inquiries Invited**

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**6 Reasons why  
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Write today for Bulletin 451 and a list of water purification plants that have gone modern.

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"DEEP WATER"

—Layne's new all color and sound motion picture on well and pump building. No obligation. Write for details now.



# *Supreme* in Ruggedness and Quality

Matching the world's foremost records of high efficiency is the ever present elements of ruggedness and quality to be found in all Layne built wells and pumps.

Each unit is built to maintain high efficiency under all conditions no matter how heavy the load may be or how long the hours of operation.

Part by part everything that goes into a Layne built well and pump is of the finest materials yet found for that particular need. This means that the parts hidden from sight, deep in the ground, are completely dependable and rugged enough for many years of excellent service.

For catalogs and other information, address

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**LAYNE & BOWLER, INC.**  
General Offices, Memphis 8, Tenn.

## **WATER WELLS**

## VERTICAL TURBINE PUMPS—WATER TREATMENT

(Continued from page 4)

**What price water**, indeed, when even the nuclear scientists want to buy it second-hand? Or perhaps a desire to check his method of determining the age of water was actually the reason why Dr. Willard F. Libby of the University of Chicago advertised last month for water "of a known age between five and twenty years." We, who had always considered water ageless, haven't quite recovered yet from the thought of Dr. Libby's "middle-aged" stuff and of tapping "an undertaker's fire extinguisher, a grocer's soda pop cooler, and a housewife's water jug" for any kind of supply. All the queasiness vanishes, however, not only in the realization that some housewife thought enough of water to treasure it for more than five years, but in the potentialities of the headlined idea of "vintage" water—a new and strong appeal on which water works men ought to be able to hang a real rate rise. Imagine being a distributor of "Eau de Lake Michigan, Pumpage 1952" or, perhaps, "Agua Swanee, Reservoired in Bond."

Getting back to Libby's liquor, though, it behooves us to report that no sufficiently large single sample of known age has yet been found. When it becomes available, scientists armed with Geiger counters will engage in a hunt for the one atom of tritium in a billion billion atoms of ordinary hydrogen that is supposed to be present in water of that age. If the hunt is successful and other hunts and other experiments eventually confirm the accuracy of Libby's method, science will have available a scale for measuring the age of water samples, which, it is said, "could be used to trace the movements of ground water, the movements of air masses, and the movements of water in the ocean, both in the form of currents and in vertical circulation." Quite frankly, we have no idea of how these wonders are to be performed, but, given a basis for making money on a supply, "enriched with tritium" we're little inclined to quibble. After all, if it's not ageless, water stands a much better chance of becoming practically priceless.

**Fluoridated water**, according to a decisive ruling of the Food and Drug Administration, does not fall within the scope of the federal Food, Drug, and Cosmetic Act, and foods prepared with the use or addition of fluoridated public water supplies are not subject to the act. Only if the processed foods contain significant quantities of fluorides may the act be invoked.

**Short courses** in radiological health are being offered to qualified applicants without charge at the Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio, from time to time. Currently basic courses are being scheduled for October 6-17, 1952, and January 19-30 and April 20-May 1, 1953. Details may be obtained from the Chief, Radiological Health Training Section, Public Health Service, at the Center.

(Continued on page 8)

# HAMMOND

**water storage vessels**

**ELEVATED  
TANKS,  
RESERVOIRS,  
SPHERES AND  
STANDPIPES**

... built to all standard  
codes and specifications  
including: A.W.W.A. •  
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(Continued from page 6)

**Gerald E. Arnold**, director of NPA's Water Resources Div., has resigned to accept the post of deputy commissioner of water for the city of Philadelphia. He will assist Samuel M. Baxter, the commissioner. Elbert J. Taylor, who had been acting chief of operations of the Bureau of Water, has transferred to the engineering staff of the Dept. of Public Works.

Arnold's successor as director of the Water Resources Div. is James Crenshaw, who had been his administrative assistant. Before entering the Navy during World War II, Crenshaw had been a member of the staff of the War Production Board's Water Div.

**Jack J. Hinman Jr.** has been appointed visiting professor in sanitary engineering, and Daniel A. Okun, associate professor, at the Dept. of Sanitary Engineering of the Univ. of North Carolina. They will replace H. G. Baity, head of the department, and Marvin L. Granstrom, assistant professor, while they are on leave, the former to work on environmental sanitation for WHO, the latter to complete his studies for the doctorate at Harvard Univ. Okun is on leave of absence from Malcolm Pirnie Engrs. for the duration of his two-year teaching assignment.

(Continued on page 10)



## For Public Water Fluoridation

### Sodium Silicofluoride—98%

(Dense Powder)

### Sodium Fluoride—97%

(Dense Powder or Granular)

White or tinted blue

Minimum of dust in handling

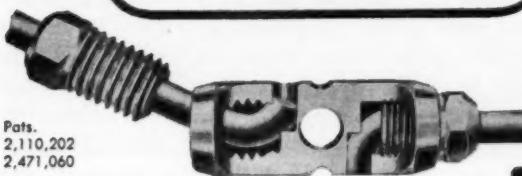
Minimum of storage space

Available in bags and drums

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50 Church Street, New York 7, N. Y.

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IN THE WRONG HOLE-  
with  
FLEXICROME  
SEWER-ROD  
COUPLINGS!"**



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**Greatest Improvement  
Since the Coupling Itself!**

This improved coupling for HIGH SPEED POWER TURNING MACHINES never assembles in the wrong (lock pin) hole, making it necessary to uncouple to use a lock pin. Saves time and money. CLICK, SNAP — IT'S HOME. "FLEXICROME" ROD —made exclusively for Flexible—is used exclusively. They are interchangeable with all "OLD STYLE" Flexible Rods.



"OLD STYLE" Rods and Couplings can still be furnished to cities that still turn their rods by hand (the slow, expensive way). Expect as good results as you had 15 YEARS AGO.



Just move coupling in or out of the ratchet or power drive shaft—pressing pin down till it clicks. Then turn right or left for hole.



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**SEWER-ROD EQUIPMENT CO.**

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**AMERICA'S LARGEST MANUFACTURER  
OF PIPE CLEANING TOOLS AND EQUIPMENT**

(Continued from page 8)

**Fluoridation** by now seems to be having an effect not only on our teeth but on what we say through them. "Some more fluoridiana," is what one of our anonymous contributors sent in last week. "Fluorophobia" and "fluorimania" are the diseases of the day. And fluor spar is fast coming to mean a fight between those so afflicted. Us it all leaves fluored!

**Speaking of language**, speaking the language seems to be one of our more obvious shortcomings. Not that we admit to the shortcoming, but reports from Secretary Jordan's recent European trip indicate that not only our friends in the Netherlands but those in the king's England itself are often unable to understand some of the "bons mots" of P&R. Proof that we're in Dutch with the Dutch at least was a statement in the well-known publication, *Water*, in which Dr. H. Kahrel of its staff indicated that he had obtained real comfort in learning from our emissary "dat 'headquarters' ook niet steeds begrijpen wat de auteur van 'Percolation and runoff' bedoelt." Small comfort, we would say, but for the fact that the statement was translated to mean "that headquarters, too, does not always understand what the author of P&R means." All of which leaves us not only most misunderstood but quite undiscouraged. After all, we too are not really trying to change things, just "refreshen" them up.

**Howard H. Jenkins**, formerly executive vice-president of American Pipe & Construction Co., of Los Angeles, has been made president of the firm, succeeding William A. Johnson, who remains as chairman of the board and a member of the executive committee. Among other changes made on August 1 are the promotions of Robert V. Edwards, sales vice-president, to the post of executive vice-president; and H. L. White, chief engineer, to the post of vice-president in charge of engineering. In addition, Elliot E. Brainard, formerly of Lock Joint Pipe Co., has joined the American group as sales vice-president.

**Vincent J. Calise**, technical director of Graver Water Conditioning Co., has been placed in charge of the company's new Research and Product Development Dept. In two additional appointments, Marvin Lane, formerly chief chemist, has been made technical manager; and William J. Lewis has been placed in charge of the Customer Service Dept.

**Thomas B. Irwin**, formerly Kansas City sales agent for U.S. Pipe & Foundry Co., has been appointed assistant western sales manager, in which capacity he will aid J. Leslie Hart at the firm's Chicago office. Bartlett G. Bretz, formerly sales representative at Kansas City, succeeds Irwin as sales agent at that city.

(Continued on page 12)

# AGAIN! CLEVELAND SELECTS STEEL PIPE FOR NEW WATER MAIN



The pictures on this page were taken recently during the installation of Section B of Cleveland's Belvoir Boulevard water main, another unit in the city's growing network of steel water lines. This new main is a project of the Department of Public Utilities, Division of Water and Heat. It is designed to bring to an end Cleveland's chief water problem, that of adequate distribution.

Section B consists of 17,030 ft of 48-in. Bethlehem Steel Pipe, tar-enamed on the outer surface. The pipe was furnished in 7/16-in., 1/2-in., and 9/16-in. thicknesses, and was installed by Joseph Kalill Co., Cleveland.

In addition to its use in Cleveland, Bethlehem Tar-Enamelled Pipe was chosen recently for water-main installations in such cities as Philadelphia, New Orleans, Cincinnati, Winston-Salem, Washington and Allentown, Pa. And for good reasons, too; for Bethlehem Pipe is economical, leak-proof, and easy to install.

If you'd like to discuss the advantages of steel pipe for water mains, we'll be pleased to have our representative call at your convenience. All you need do is drop a line to the nearest Bethlehem office.



## HERE'S WHY YOU'LL LIKE TO USE BETHLEHEM PIPE

1. It is both leak-proof and bottle-tight. After installation, it is free from costly broken joints which could lead to water contamination.
2. Its beam strength and resilience enable it to resist the effects of soil movement after installation. The joints are actually the strong points of the system.
3. The pipe is very easy to handle. Its 40-ft lengths and light weight facilitate rapid, economical stringing and installation.
4. Its smooth, uniform layer of coal-tar enamel prevents incrustation and corrosion. It can be applied to both surfaces.
5. It maintains high flow-coefficients, ensuring dependability year after year.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.  
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast  
Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation



**BETHLEHEM Tar-Enamelled WATER PIPE**

(Continued from page 10)

**Clyde R. Harvill**, after a year of service with the Water Resources Div. of NPA, has returned to his post with the Houston, Tex., Water Div. In the course of his work with the production agency, he helped pass on 6,500 applications for water and sewer projects, approving allotments of almost 600,000 tons of steel, 10,000,000 lb of copper, and 600,000 lb of aluminum. The cost of the projects was almost \$2,250,000,000.

**John Larsen**, formerly sales engineer of the Water & Sewage Dept. of Omega Machine Co., has been appointed assistant sales manager in charge of water and sewage sales.

**A. P. Black** has added to his honors the distinction of being elected regional vice president of the Southern Assn. of Science and Industry.

**A Kansas City, Mo.**, office has been opened at 207 Congress Bldg., 3527 Broadway, by Builders-Providence, Inc., and Omega Machine Co. Sales manager in charge of the office is Ray W. Lindsey, formerly sales engineer at Chicago.

(Continued on page 14)



## LIMITORQUE<sup>®</sup>

### VALVE CONTROLS

From coast to coast, hundreds of LimiTorque Controls are in service in water works and sewage disposal plants for automatic or remote operation of valves up to 120 inch diameter. Why is acceptance so widespread? Because LimiTorque Operators are designed to provide dependable, safe and sure valve actuation at all times.

LimiTorque is self-contained and is applicable to all makes of valves. Any available power source may be used to actuate the operator: Electricity, water, air, oil, gas, etc.

A feature of LimiTorque is the torque limit switch which controls the closing thrust on the valve stem and prevents damage to valve operating parts.

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...whatever your  
**VALVE PROBLEMS...**



IOWA Square Bottom Gate Valves—Throttling service—  
 Wash water lines



IOWA Chain Operated Gate Valves  
 Manual operation—Close quarters

**IOWA**

**is ready to meet  
 your every  
 requirement....**

IOWA'S complete line of valves is specially designed for severe and particular operating conditions in filter plants, sewage disposal plants, reservoirs, dams, pumping stations, distribution systems or wherever water control is required. Let us help you solve your problems. Specify IOWA valves and get the best!

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**VALVE COMPANY**

201-299 N. Talman Ave., Chicago 80, Ill. • A Subsidiary of James B. Clow & Sons



(Continued from page 12)

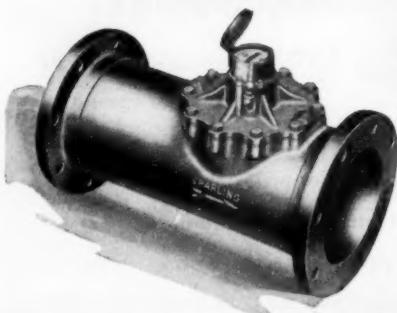
**The miracle of St. Walston's well** turned out to be slightly the worse for a thousand years of wear last July when its water, which had been drunk to cure the ills of ten centuries of Britons, was officially pronounced polluted. What with the similar closing of Madrid's Fountain of Health only two months before, it's getting so a pilgrim can hardly find any water to turn to—except, of course, at the tap in his own home, where he can always get a glassful of panacea for practically nothing.

**William D. Hudson** has been appointed assistant chief engineer of Pitometer Co., hydraulic and distribution engineering firm. He has been with the organization for eleven years, in which time he has supervised distribution system studies in many cities throughout the U.S., Canada, and Puerto Rico.

**Enlarged quarters** are being enjoyed by the headquarters of Graver Water Conditioning Co. at the same New York address—216 W. 14th St.—it has been located at since its move from Chicago three years ago. Doubling of the unit's floor space has permitted expansion of its facilities.

(Continued on page 16)

## SPARLING MAIN-LINE METERS for SERVICE and SATISFACTION



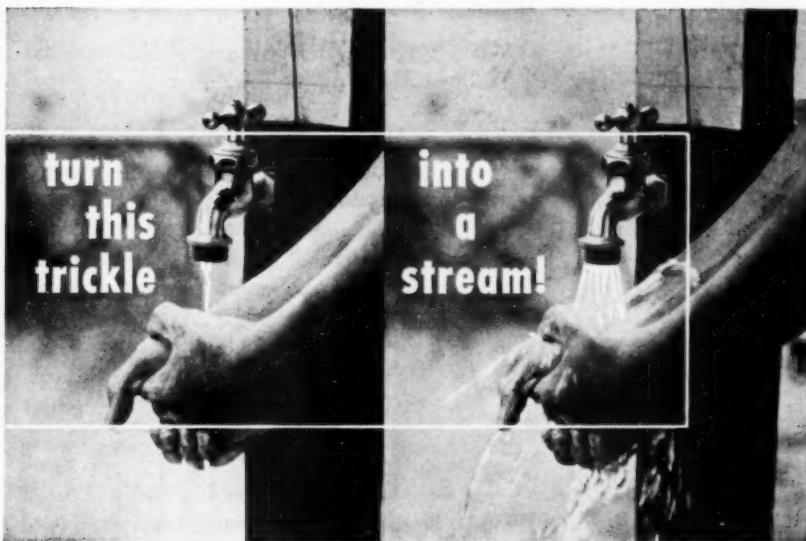
Since 1919

Year after year over 20,000 Sparling Meters measure main-line flows in water works, sewage disposal plants and a score of industries that require accurate liquid measurement over a wide range of flows. When you install Sparling Meters you are in good company!

*Bulletin 311 comes at your request.*

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If loss of pressure is your water problem, the source of trouble may be tuberculation and corrosion in your pipelines. In this case the Centriline process can turn this trickle into a stream . . . and can put smiles back on the faces of the taxpayers of your community.

Centrilining is the application of cement mortar to the walls of pipelines in place, after cleaning. At a fraction of the cost and trouble of replacement, Centrilining extends the life of old pipes *indefinitely*. For complete information on this time proven process, write for your free copy of Centriline's new booklet.

*Pipelines 4" to 14" are cement-lined by the Tate Process.*

#### CEMENT-MORTAR LININGS FOR PIPES IN PLACE

2,500,000 FEET  OF EXPERIENCE

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ON THE WEST COAST, WRITE PIPE LININGS, INC., P. O. BOX 3428,  
TERMINAL ANNEX, LOS ANGELES, CALIFORNIA

(Continued from page 14)

**Nicholas A. Rose**, consulting ground water geologist of Houston, has moved his office to 1010 Dennis Ave., Houston 2, Tex.

**A Painless Parker** in our own field is the one named Frank, who recently took over as Safety Coordinator for the East Bay Municipal Utility Dist. at Oakland, Calif. What caused us to recall the purported painlessness of the predecessor Parker was one sentence in the bulletin introducing him to his fellow employees. "Frank," it said, "has been around now for a few weeks, but due to a recent automobile accident has not been able to meet everyone." He's probably in hiding.

**William O. Lovejoy**, formerly of the Wyandotte Chemical Corp., has joined the Pittsburgh Testing Lab. in the capacity of chemical engineer at the Jacksonville, Fla., branch.

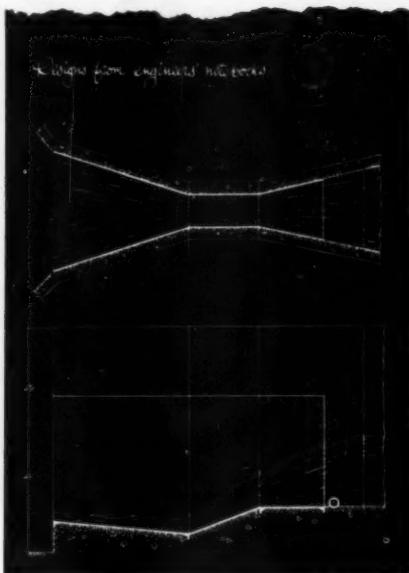
**John Thomas Hassey** has joined Neptune Meter Co. and will assist Charles W. Krause in the New England territory, with headquarters at Boston.

(Continued on page 18)

**Refinite** serves the World  
WITH WATER CONDITIONING  
EQUIPMENT & SERVICE

**Refinite** OMAHA, NEBRASKA  
WATER REFINING EQUIPMENT

WRITE FOR FREE  
BULLETINS ON HOW REFINITE  
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**Parshall****Venturi****Flume****lined with****EVERDUR****for measurement of sewage**

Flow measurement in open channels is readily obtained with this Parshall Venturi Flume. It has low head loss and can handle liquids containing solids because the solids can settle at no point. Its accuracy—satisfactory for most waste disposal problems—depends upon maintaining correct dimensions, particularly in the throat.

In providing this flume in the 3 or 4 smallest sizes, with accurate metering equipment, the Simplex Valve & Meter Co. realized that shifting forms, shrinking concrete, and erosion might set up sizable inaccuracies. Their solution was a liner of .1019-in. EVERDUR\* (ANACONDA Copper-Silicon Alloy) sheets welded to angle irons set in concrete. Everdur's smoothness prevents solid accumulations where floor

slope causes the flow to lose head. Over a long period of time this Parshall Flume will provide true flow measurement with minimum maintenance—thanks to the strength and corrosion-resistance of this built-up, light-weight Everdur structure.

Everdur is produced in practically all commercial forms, including casting ingots. It can readily be cast, forged, formed, machined and fabricated by all the usual methods and is ideal for assemblies such as gates, screens, float chambers, weirs, troughs, manhole steps, gate guides, stems and bolts.

For more information about Everdur, write for Publication E-11 to The American Brass Co., Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

\*Reg. U. S. Pat. Off. 52151A

specify Everdur

**ANACONDA®** Copper-Silicon Alloys**STRONG • WELDABLE • WORKABLE • CORROSION-RESISTANT**

(Continued from page 16)

**For the tired water works man**, we at last have a practically practical suggestion: Remove the wrapper from one of the packages shown in the accompanying illustration; drop the contents into your bathtub; then—but first let the material dissolve completely—"you will enjoy all the benefits of a healthy mineral bath in the privacy and convenience of your home." The package to which we've been referring throughout, of course, is one filled with a mineral formula preparation developed by the Desert Springs Co. of Pasadena, Calif. The package-holder is merely the means by which the company is sure to obtain publicity in publication such as this. Oh yes! *Just add water* and the product will give "amazing relief for muscular aches and pains, and makes one sleep like a carefree child as a result of its relaxing action . . . make your aches and pains go down the drain. It's guaranteed!" At the moment, Desert Springs is sold only in bath-size packages, but undoubtedly the company is ready to talk business with any water works man who may want to make mineral water of the stuff he pipes to his customers.



**Plastic pipe couplings** just produced by Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio, include new insert type ells and tees to facilitate making sharp bends or take-offs. The fittings are tightened with a screwdriver, using an ordinary hand saw to cut the pipe where desired.

(Continued on page 68)

## Filter Sand and Gravel

Well Washed and Carefully Graded to Any Specification.

Prompt Shipment in Bulk or in Bags of 100 lb. Each.

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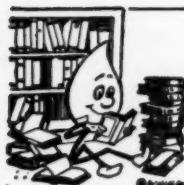
# GUARD YOUR WATER SUPPLY—

In normal times or in times of emergency, you can count on %Proportioneers% Heavy Duty CHEM-O-FEEDER. Look at the important advantages which make Chem-O-Feeder the sure way to safeguard water supplies:

- 1 All parts coming in contact with treating chemicals are of See-Thru plastic and Neoprene rubber which are unaffected.
- 2 Alum, Ammonia, Copper Sulphate, Hypochlorites and Fluorides can be fed by standard units.
- 3 Pumping action is visible to the operator.
- 4 This feeder has the widest dosage adjustment range and changes may be made "in operation".
- 5 Compact construction encloses all moving parts in oil bath requiring no lubrication maintenance.
- 6 Accessories for complete installation included with feeder.
- 7 Parts for all models are in stock at strategic service centers.
- 8 Feeder can be readily converted to slurry feeding or the handling of concentrated corrosive liquids.

Write, today, for Bulletin SAN-7, the complete story on Simplex, Duplex, and Triplex Chem-O-Feeders. %Proportioneers, Inc., 365 Harris Ave., Providence 1, R. I.

**% PROPORTIONEERS, INC. %**



## The Reading Meter

**Waterworks Byelaws and Fittings.** *Delwyn G. Davies.* The Colliery Guardian Co., Ltd., 30 Furnival St., London, E.C.4, England (1952) 280 pp.; 30s (approximately \$4.20 U.S.)

This survey of regulations governing water services and plumbing fixtures in Britain is ambitiously conceived, beginning with a historical survey that goes back to Sir John Harrington's invention of what is now in England termed the "W.C." and including a critical appraisal of existing standards and regulations in the form of an annotated Model Byelaw. The material is clearly and concisely presented, and the book should prove useful on both sides of the Atlantic.

**Water—A study of its properties, its constitution, its circulation on the earth, and its utilization by man.** *Cyril S. Fox.* The Philosophical Library, 15 E. 40th St., New York 16, N.Y. (1952) 148 pp.; \$8.75

This monograph on the elemental characteristics of water and its impingement upon our environment forms the first of a series of volumes projected, or already in print, on water supply, and makes a convenient companion volume to *The Geology of Water Supply*—another in the series, and by the same author (see October 1950 P&R, p. 78). Detailed statistics combine with a striking series of photographs to document the author's exposition. In addition to the section on the physical properties of water and its occurrence, the work (and damage) done by water in its natural state, and the work man makes it do, are discussed.

**Water Resources of Hamma Hamma, Duckabush, and Dosewallips Rivers, Washington.** *F. F. Lawrence.* U.S. Geological Survey, Washington 25, D.C. (1952) 24 pp.; free

Not "where the goona goona, nooka nooka, apua go swimming by," but somewhere high in the Olympic mountains. Besides the report has to do with the power potential of public lands and wouldn't interest you. But what a title!

(Continued on page 76)

*When  
pipe  
efficiency*

*drops  
you*

*need... National*

When pumping costs rise, pressures fall and capacity is way down—  
You need *National* cleaning!

Often, lines assumed to be in top operating condition are actually delivering less than half of their rated capacity. For instance—a tuberculated 48" pipe, having a co-efficient of 93 can carry no more water than a clean 42" pipe. Think how much difference this makes in costs when it must be compensated for by either greater power consumption at the pumping station or by larger mains in the ground.

Remember, the National Water Main Cleaning Company *guarantees* to restore any water main to 95% of its original carrying capacity.

*There's no obligation when National's  
engineers inspect and estimate  
cleaning costs of your mains, so write  
or phone today!*



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50 Church Street • New York, N.Y.

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LARGE-DIAMETER AND  
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sewers, and culverts



When you need large-diameter or long-length concrete pipe, Universal can deliver . . . either by shipping from one of 26 plant locations or by moving in mobile equipment and manufacturing on the site.

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## Correspondence



### McIlroy Was There

#### To the Editor:

Having read page 80 of your latest effusion (July P&R), we are glad to hear the Midwest Research Institute has acquired a new McIlroy Analyzer. We are also glad to know that there are two others at Washington State College and Cornell.

We are wondering how many of the JOURNAL's readers will know where on earth the Midwest Research Inst. is, and incidentally they might not know where W.S.C. and C.U. are located. If my memory is not too tricky, I recall that W.S.C. is at Pullman, Wash., and Cornell at Ithaca, N.Y.

E. L. FILBY

Black & Veatch, Cons. Engrs.  
Kansas City, Mo.; Aug. 1, 1952

*As a neighbor of Midwest Research Inst. and an alumnus of Cornell, friend Filby can only well wonder whereabouts W.S.C. But there's truth in that there jest and we'll endeavor to be more geographical in the future.*  
—ED.

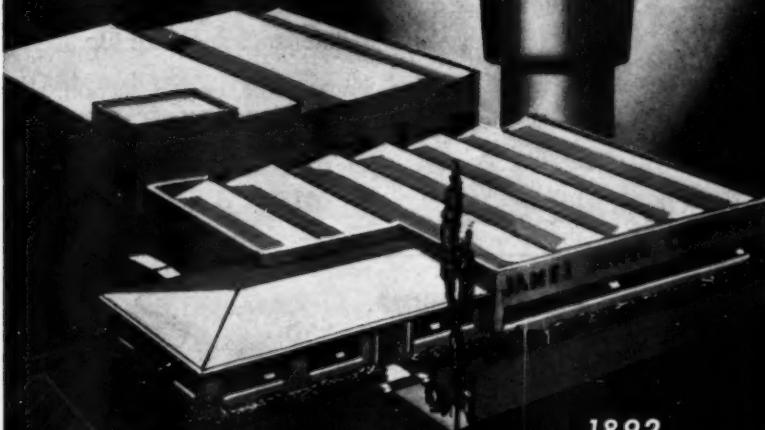
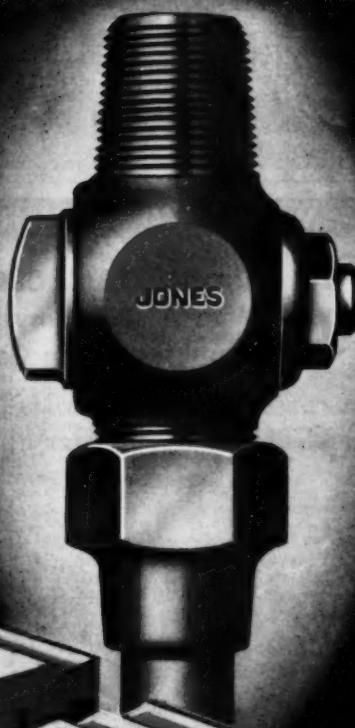
### Sig Heil

#### To the Editor:

I was interested in checking your summation of attendance at the Kansas City meeting (June P&R p. 2) once more from the viewpoint of transportation. By dividing the number attending into zones, I came up with the following tabulation, which reveals the distance traveled by the registrants:

(Continued on page 88)

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# NOTES

for the engineer's note book

-ON-

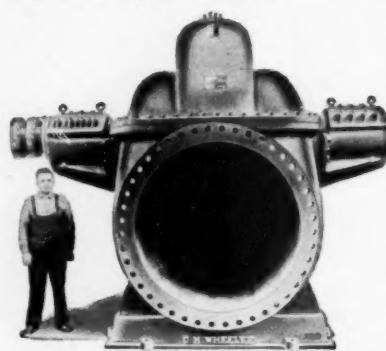
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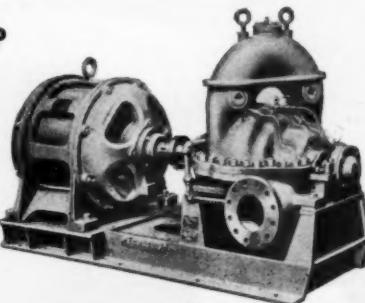


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*Applications received July 1 to July 31, 1952*

**Aiken, James F., Jr.**, San. Engr., Div. of Sanitation, State Board of Health, Univ. of Kansas, Lawrence, Kan. (July '52) *P*

**Arkansas Public Service Com.**, V. O. Purvis, Jr., Chief Engr., 422 State Capitol, Little Rock, Ark. (Corp. M. July '52)

**Barney, William E.**, Engr. of Design, Water Dept., Rm. 319, City Hall, Pasadena, Calif. (July '52) *MR*

**Beck, R. W., & Assoc.**, John R. Wallace, Jr., Sr. Supervising Engr., 7th & Olive St., Seattle 1, Wash. (Corp. M. July '52)

**Behner, John Louis**, Civ. Engr., James M. Montgomery, Cons. Engr., 15 N. Oak-land Ave., Pasadena 1, Calif. (July '52) *MR*

**Bender, Kenneth Edwin**, Hydr. Field Engr., The Pitometer Co., 50 Church St., New York 7, N.Y. (July '52) *M*

**Bennett, Harry**, Partner-Mgr., Culligan Soft Water Service, 3308 Highland Ave., Manhattan Beach, Calif. (July '52)

**Borton, John Ross**, Pump Operator, City Light & Water Utilities, 223 Della St., Kalamazoo, Mich. (July '52) *MP*

**Brogdon, Melvin C.**, Water Supt., Water Works, Monon, Ind. (July '52) *M*

**Coast Counties Gas & Electric Co.**, Harry P. Prudhomme, Regional Gas Engr., 1543 Pacific Ave., Santa Cruz., Calif. (Corp. M. July '52)

**Couey, Leo L.**, Supt., Rockwood Water Dist., 18230 S.E. Stark St., Portland, 16, Ore. (July '52) *M*

**Crenna, Fred**, Supt., Water & Sewer Dept., Bessemer, Mich. (July '52) *MRP*

**Decker, George Rhame**, Meter Repairman, Water Dept., City Hall, Fort Lauderdale, Fla. (July '52) *R*

**Dickinson Olivera, Fausto Ignacio**, Service Chem. Engr., Dearborn Chemical Co., Plaza de Buenavista No. 2, Desp. 406, Mexico 3, D.F., Mexico (July '52) *M*

**Dorner, William J.**, Owner, W. J. Dorner, 715 Dekum Bldg., Portland 4, Ore. (July '52) *MP*

**Emanuel, James Tucker**, San. Eng. Asst., San. Eng. Div., Dept. of Water & Power, 207 S. Broadway, Los Angeles 12, Calif. (July '52) *P*

**Finley, Belden**, Water Distr. Supt., Water & Light Dept., 1720 S. 13th St., Lincoln, Neb. (July '52) *M*

**Finnigan, Edward, Jr.**, Shift Operator, Dept. of Munic. Service, Water Purification Div., 562 Orange St., Wyandotte, Mich. (July '52) *P*

**Forbes, Henry L.**, Supt., Hinds County Water Co., Box 8008 Battlefield Station, Jackson, Miss. (July '52) *MP*

**Gilmore, William H.**, Asst. San. Engr., Bureau of Sanitation, State Dept. of Health, Montgomery, Ala. (July '52) *P*

**Greater Victoria Water Dist.**, R. A. Upward, Chief Comr., 685 Yates St., Victoria, B.C. (Corp. M. July '52)

**Hinton, Norman Horace**, Waterworks Foreman, 1394 Pine Ave., Trail, B.C. (July '52) *MP*

**Holland, Bernard T.**, Comr. of Finance, 113 City Hall, St. Paul, Minn. (July '52)

**Holwerda, James G.**, Staff Geologist, Johnston International, Rm. 729, 612 S. Flower St., Los Angeles 17, Calif. (July '52) *R*

**Huett, David O.**, Supt., Petit Jean State Park, Route 3, Morrilton, Ark. (July '52) *P*

**Hyde, Thomas Baskerville**, Dist. San. Engr., Div. of San. Eng., State Dept. of Health, Pierre, S.D. (Jan. '52) *RP*

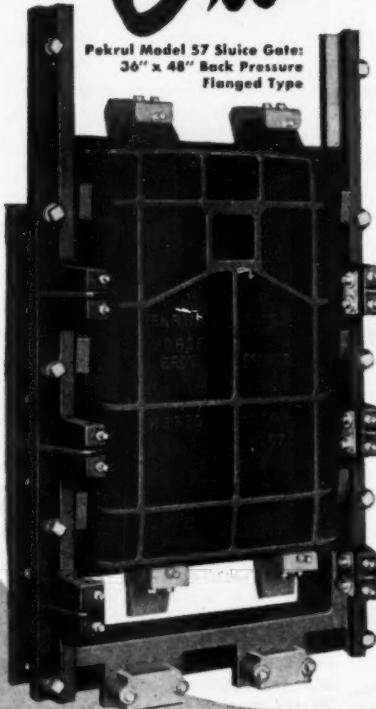
**Isley, Jack W.**, Sales Repr., Neptune Meter Co., 1312 Roosevelt Ave., Ames, Iowa (July '52) *M*

*(Continued on page 32)*

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Write for Catalog 49

(Continued from page 30)

**Johnson, Owen C.**, Engr., Water Chemists, Inc., 1700 S. Main St., Los Angeles 15, Calif. (Apr. '52) *P*

**Kalda, Donald C.**, Dist. San. Engr., Div. of San. Eng., State Dept. of Health, c/o City Health Dept., City Hall, Sioux Falls, S.D. (Jan. '52) *P*

**Karlinski, Theodore H.**, Inspector, Div. of Water, Foot Porter Ave., Buffalo 1, N.Y. (July '52)

**Kaufmann, Dale W.**, Chief Chem. Engr., International Salt Co., Inc., 638 Marine Trust Bldg., Buffalo 3, N.Y. (July '52) *MP*

**Kispert, Edward C.**, Asst. Supervisor of Water Purif., Water Works Filtration Plant, 5650 Kellogg Ave., Cincinnati 28, Ohio (July '52) *P*

**Kramer, Frederick L.**; *see* Neodesha (Kan.)

**Kunder, Richard F.**, Field Engr., The Pitometer Co., Inc., 6734 Marquette St., St. Louis 9, Mo. (July '52) *MP*

**Lee, Arthur T.**, Owner, Utilities Supply Co., W. Dixie Highway, North Miami Beach, Fla. (July '52) *M*

**Lyle, Duane C.**, Repr., Hays Mfg. Co., Rm. 1015, 465 California St., San Francisco, Calif. (July '52)

**Marti, George, Jr.**, Sales Engr., Infilco Inc., 401 Triad Bldg., Baton Rouge, La. (July '52) *P*

**McCullough, Sam H.**, Dist. Mgr., Refinite Corp., Box 1772, Memphis, Tenn. (July '52) *P*

**Mees, Donald George**, Engr., Mountain States Inspection Bureau, 801 Gas & Electric Bldg., Denver, Colo. (July '52)

**Miner, John Van Horne, Jr.**, Sr. Asst. San. Engr., U.S. Public Health Service, Region VI, 50-7th St., N.E., Atlanta 5, Ga. (Jan. '52) *P*

**Morey, James B.**, Mech. Engr. & Field Repr., The International Nickel Co., Inc., 538 Petroleum Bldg., Los Angeles 15, Calif. (July '52) *MP*

**Muslim Ali, Syed**, Supt. Filter Plant, Karachi Joint Water Board, Gharo, Sind, Pakistan (July '52)

(Continued on page 34)

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1 1/4"	1.850	1.380	120	.477	300' "
1 1/2"	2.260	1.610	120	.790	250' "
2"	3.000	2.070	120	1.88	200' "
2 1/2"	2.495	2.070	75	.620	200' "
3"	2.950	2.470	75	.820	150' "
3 1/2"	3.670	3.070	75	1.280	100' "
4"	4.820	4.030	75	2.200	25' straight
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**Nehe, Herman**, Sales Repr., Western Supply Co., 226 Pine St., Chadron, Neb. (July '52) *M*

**Neodesha, City of**, Frederick L. Kramer, City Engr., Neodesha, Kan. (Corp. M. July '52)

**Nordness, Elmer L.**, Asst. Water Supt., Water Dept., City Hall, Madison, Wis. (July '52) *MRP*

**North Platte Water Dept.**, M. L. Sievers, Box 696, North Platte, Neb. (Munic. Sv. Sub. July '52)

**O'Grady, Joseph F.**, Sales Mgr., Water Meter Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh, Pa. (July '52)

**O'Neill, Albert Ellis**, 510 Rugby Ave., Orlando, Fla. (July '52) *MRP*

**Owen, Stanley Felipe**, Exec. Engr., Public Works Dept., Alor Star, Kedah, Malaya (July '52) *MRP*

**Patterson, Arch Murphy**, Mgr., Water Works, Holly Grove, Ark. (July '52) *MRP*

**Potts, Raymond, Jr.**, Chemist, Filtration Plant, 837 Crosby St., N.W., Grand Rapids, Mich. (July '52)

**Prudhomme, Harry P.**; *see* Coast Counties Gas & Electric Co. (Calif.)

**Pryce, John Norman**, Chief Fire Protection Engr., Dominion Board of Insurance Underwriters, 460 St. John St., Montreal, Que. (July '52)

**Purvis, V. O.**; *see* Arkansas Public Service Com.

**Ramsey, J. Basil**; *see* Wainwright, Ramsey & Lancaster

**Reid, Hubert**, City Engr., Box 215, Leachville, Ark. (July '52) *P*

**Riverside County Health Dept., The**, Everett M. Stone, County Health Officer, Court House, Riverside, Calif. (Corp. M. July '52)

**Sabo, Albert**, Supt. of Distr. & Production, Water Dept., 1107 S. Burdick St., Kalamazoo, Mich. (July '52) *M*

**Schlissel, Morris**, Chief Chemist & Gen. Sales Mgr., Metropolitan Refining Co., Inc., 50-23-23rd St., Long Island City 1, N.Y. (July '52) *P*

**Seckman, A. L.**, Supt., Board of Public Works, Hannibal, Mo. (July '52)

**Shadel, Clarence**, Engr., Water Works Div., Public Service Dept., Burbank, Calif. (July '52) *M*

**Shera, Charles Emerson**, Supt., Utilities Com., Wingham, Ont. (July '52) *M*

**Short, Russell**, Sales Repr., Western Supply Co., Box 428, North Platte, Neb. (July '52)

**Sievers, M. L.**; *see* North Platte (Neb.) Water Dept.

**Smith, Bernard J.**, Cons. Engr., 3405 Milton St., Rm. 203, Dallas 5, Tex. (July '52) *R*

**Snedaker, Robert**, Water Supt., Middham, N.J. (July '52) *MP*

**Starr, Francis B.**, Sales Repr., Western Supply Co., 501 W. "M" St., McCook, Neb. (July '52)

**Stone, E. E.**, Mgr., Water Works, Atkins, Ark. (July '52) *M*

**Stone, Everett M.**; *see* Riverside County (Calif.) Health Dept.

**Strumpfer, Robert D.**, Personnel & Public Relations Director, Light & Water Utilities, City Hall, Kalamazoo, Mich. (July '52) *M*

**Struthers, Ray**, Water Supt., Pendleton, Ore. (July '52) *M*

**Thul, Norbert J.**, Supt., Water Dept., Ellinwood, Kan. (July '52) *MRP*

**Tinius, Frank B.**, Sales Repr., Western Supply Co., 820 "N" St., Lincoln, Neb. (July '52)

**Tufte, Edward E.**, Civ. Engr., Eng. Div., Phoenix, Ariz. (July '52) *PD*

**Uhlmeyer, Vance N.**, Asst. Chief Engr., Gas & Water, Wisconsin Power & Light Co., 122 W. Washington Ave., Madison 1, Wis. (July '52) *M*

**Upward, R. A.**; *see* Greater Victoria (B.C.) Water Dist.

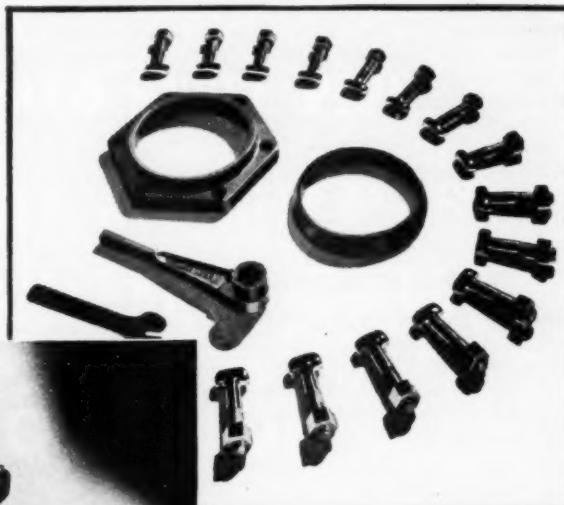
**Wainwright, Ramsey & Lancaster**, J. Basil Ramsey, 70 Pine St., New York 5, N.Y. (Corp. M. July '52)

**Wallace, John R., Jr., Sr.** Supervising Engr., R. W. Beck & Assoc., 7th & Olive St., Seattle, Wash. (July '52) *MRP*

**Weber, Walter H.**, Sales Repr., Western Supply Co., 1641 Prospect St., Lincoln, Neb. (July '52)

(Continued on page 36)

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**Wheeler, Henry L.**, Sales Repr., Hays Mfg. Co., 111 Brookfield Rd., North Syracuse, N. Y. (July '52)

**Williams, Theodore Castle**, San. Engr., Williams & Works, 227 Ottawa St., N.W., Grand Rapids, Mich. (July '52) *R*

#### REINSTATEMENTS

**Kelley, W. D.**, Cons. Engr., 1206 Manwha Blvd., Charleston, W.Va. (Oct. '40)

**Trygg, John E.**, Chief, Water Supply & Waste Disposal Sec., State Dept. of Health, Civil Courts Bldg., New Orleans 7, La. (Oct. '45)

#### LOSSES

#### DEATHS

**Etnire, Ben S.**, Supt., Water Dept., Augusta, Kan. (Apr. '51)

**McLaughlin, H. L.**, Salesman, Rockwell Mfg. Co., 1310 Race St., Denver 6, Colo. (Mar. '26)

#### RESIGNATIONS

**Anderson, Leonard Meade**, Water Operator, Water Dept., 12340 N.E. 8th Ave., North Miami, Fla. (Oct. '51) *P*

**Bradbury, Alfred M.**, Sales Engr., James B. Clow & Sons, Birmingham, Ala. (Oct. '50)

**Bushway, Walter B.**, Supt., Water Dept., Town Hall, Brookline 46, Mass. (Jan. '42) *M*

**Consolidated Water Power & Paper Co.**, Mailing No. 26, Wisconsin Rapids, Wis. (Corp. M. Jan. '45)

**Gauer, Paul G.**, Chief Engr., Pumping Dept., Water Dept., Madison, Wis. (May '30)

**McDermitt, Pat E.**, Comr. of Finance & Member of Water Board, St. Paul 2, Minn. (Jan. '50)

(Continued on page 38)

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**Miller, Charles R.**, Village Mgr., Village Hall, Winnetka, Ill. (Oct. '41) *M*

**Plotkin, Sheldon N.**, Chem. Engr., Water Chemists, Inc., 1700 S. Main St., Los Angeles 15, Calif. (Oct. '47) *P*

**Pomares, Marino L., Jr.**, Partner, Culligan Soft Water Service, 3308 Highland Ave., Manhattan Beach, Calif. (Jan. '50)

**South Bend City Water Works**, Edwin Turnick, Supt., 224 N. Main St., South Bend, Ind. (Corp. M. Oct. '49)

**Steib, F. L.**, 123—2nd St., S., Wisconsin Rapids, Wis. (Jan. '42)

**Walkwitz, Clarence Arthur**, Gen. Engr., Office of Public Works, City Hall, Wheaton, Ill. (Jan. '51) *MP*

**CHANGES IN ADDRESS**

*Changes received between July 5 and August 5, 1952*

**Aguilar V., J. Francisco**, Edif. Compania Salvadorena del Cafe 402, San Salvador, El Salvador (Jan. '46)

**Allison, S. L.**, Supt., Sewer Dept., 901 Ocean Dr., Corpus Christi, Tex. (July '47)

**Arbuthnot, James B.**, United Nations World Health Organization, Box 1517, Alexandria, Egypt (Oct. '46) *P*

**Armstrong, Roger W.**, 50 Cherry Lane, Basking Ridge, N.J. (Apr. '16)

**Barr, Norman L., Jr.**, Dresher Rd., RFD, Hatboro, Pa. (Jan. '51)

**Bennett, A. L.**, Eng. Div., State Health Dept., Des Moines 19, Iowa (Oct. '49) *MRPD*

**Berry, Rollie D.**, 124 N. 52nd Ave., Yakima, Wash. (Jan. '52) *MRPD*

**Brisbane, Eugene C.**, Vice-Pres., Ball Valve Co., 1227 Georgiana St., Santa Monica, Calif. (Jan. '36) *P*

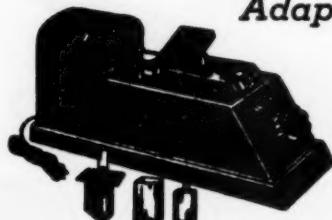
**Brown, James R.**, 620 Hinman Ave., Evanston, Ill. (July '34)

**Burba, Foster S.**, California Co., Box 20, Venice, La. (Jan. '49)

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**Busch, Arthur W.**, Apartment 5, 1743 E. Adelaide Dr., Tucson, Ariz. (Jr. M. Jan. '50) *P*

**Campbell, R. C.**, Supt., Water Works, Meridan, Miss. (Apr. '48) *PD*

**Coblentz, Maurice H.**, Public Health Engr., Technical Cooperation Administration, c/o U. S. Legation, Amman, Jordan (Aug. '29)

**Culbertson, Thomas M.**, Cons. Geologist, Box 871, Midland, Tex. (Affil. Oct. '51)

**Durham, Charles W.**, Cons. Engr., Henningson, Durham & Richardson, 626 Standard Oil Bldg., Omaha, Neb. (Jan. '49)

**Evans, Charles A.**, 114 Chetfield St., N.E., Crosland Park, Aiken, S.C. (July '47) *D*

**Foly, Joseph**, Power Group, May Plant, E. I. du Pont de Nemours & Co., Camden, S.C. (Apr. '51) *RP*

**Gillespie, Chester G.**, 15027 Natalye Rd., Los Gatos, Calif. (June '11) *P*

**Gomez Laurens, Gilberto**, Carrera 15 No. 19-51, Apdo. 101, Bogota, Colombia (Oct. '49)

**Harvill, Clyde R.**, Water Div., City Hall, Houston, Tex. (Apr. '41) *MRP*

**Helmrreich, Merwin Rea**, Administrative Officer, Board of Water Supply, Box 3410, Honolulu 1, Hawaii (Apr. '52) *M*

**Meyer, Harlan W.**, c/o City Engr.'s Office, Rapid City, S.D. (Apr. '52)

**Miller, Howard D.**, Gen. Delivery, Tullahoma, Tenn. (Oct. '49)

**Moore, William Edgar**, Salesman, Neptune Meter Co., 814 S. Lincoln St., Spokane, Wash. (Jan. '52) *M*

**Naylor, George Wilson**, Riverton Consolidated Water Co., 46 S. 3rd St., Lemoyne, Pa. (July '35)

**O'Neill, Ralph W.**, Cons. Engr., 1734 Cleveland Rd., Glendale 2, Calif. (Jan. '44) *MRP*

**Patel, Bapubhai D.**, Gujarat Cement Pipe Co., Nachiketa, Ahmedabad 8, Maninagar, India (July '49)

**Pearson, D. C.**, Harbor Defense Unit, Navy 128, FPO, San Francisco, Calif. (July '51)

**Quandreny G., Jorge L.**, Public Health Engr., 810 Calle 9, Apdo. 4, entre 14 y 16 Almendra, Marianao, Havana, Cuba (Apr. '51)

**Ray, Harry**, Secy. & Supt., Bethel Water Dist., 2495 Pershing Ave., Eugene, Ore. (Jan. '48) *MD*

**Rihm, Alexander, Jr.**, 6 Merrifield Pl., Delmar, N.Y. (July '43) *RP*

**Ross, William Anthony**, Box 425, Ancon, Canal Zone (July '50) *MRP*

**Shuey, Bruce Stanley**, Water Works, Water Treatment Plant, Ottawa St., Dayton, Ohio (July '51) *P*

**Socha, Max K.**, In Charge, Water Works & Supply Div., Dept. of Water & Power, 410 Ducommun St., Los Angeles 12, Calif. (Feb. '23) *MR*

**Stearns, H. F.**, Pres., Horton Steel Works, Ltd., 330 Bay St., Toronto, Ont. (Jan. '49)

**Swab, Bernal H.**, 1911 W. Linwood St., Oklahoma City, Okla. (Mar. '30)

**Taber, Douglass**, Dist. Sales Mgr., Builders-Provident, Inc., 434 Allegheny River Blvd., Oakmont, Pa. (Oct. '51) *P*

**Taylor Forge & Pipe Works**, Frank S. G. Williams, 50 Church St., New York 7, N.Y. (Assoc. M. July '48)

**Towers, John William**, c/o Basil M. DeLashmutt, 1327 N. Court House Rd., Arlington, Va. (July '51) *MRP*

**Unger, Gilbert C., Jr.**, 425-17th Ave., N., Apartment 2, St. Petersburg, Fla. (Jan. '50) *M*

**Updegraff, Winston R.**, Mgr. & Editor, *Western City Magazine*, 440 Statler Center Office Bldg., Los Angeles 17, Calif. (July '48)

**Voight, Otto D.**, Prin. Engr., Corps of Engrs., U.S. Army, 1st & Douglas Sts., N.W., Washington 25, D.C. (Jan. '47) *M*

**Watson, Edmund J.**, Eng. Div., The Nestle Co., Inc., 2 William St., White Plains, N.Y. (Jan. '51)

**West Memphis Light & Water Dept.**, Box 607, West Memphis, Ark. (Corp. M. Jan. '50)

**Williams, Frank S. G.**; *see* Taylor Forge & Pipe Works

**Williamson, A. E., Jr.**, Sr. San. Engr., Beirut, Lebanon, c/o Mail Room, U.S. Dept. of State, Washington 25, D.C. (Jan. '48) *MRP*

**Zadigan, Ruben**, 2 Rim Lane, Levittown, N.Y. (Oct. '42)

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### CHEMICAL ANALYSIS

**Total Hardness of Water by the Versenate Method. Direct Titration With Ethylenediaminetetraacetic Acid (EDTA).** J. E. HOULIHAN. *Analyst (Br.)*, 77:158 ('52). The method described is based on the method of Schwarzenbach and his co-workers as modified by Betz and Noll. The Ca and Mg ions are titrated directly with a soln. of ethylenediamine tetraacetate to produce an undissocd. complex in the presence of Eriochrome Black T; the indicator loses its red color and changes from purple to blue at the end point. Satisfactory agreement with the more tedious Pfeifer-Wartha procedure is achieved.—CA.

**Manganese Contents of Natural Waters.** I. MOTOHARU TANAKA. *J. Chem. Soc. Japan, Pure Chem. Sec.*, 72:29 ('51). Examples are given of application of colorimetric detn. of Mn with  $\text{Ag}_2\text{O}_2$  to hot-spring and river waters. The chlorine ion present in natural waters is removed by the addn. of  $\text{AgNO}_3$ . The  $\text{AgCl}$  ppt. is filtered and the filtrate is oxidized with  $\text{Ag}_2\text{O}_2$  and the developed color of permanganate is detd. colorimetrically. Since the iron hydroxide ppt. formed during transportation of the samples contains Mn, Mn should be detd. on the spot. II. *Ibid.*, 32. Copptn. of Mn with Fe hydroxide is used as a concn. method. Iron hydroxide is pptd. by addn. of 3 N NaOH at 80°C in the presence of  $\text{H}_2\text{O}_2$  as oxidizing agent. The ppt. is dissolved in dil.  $\text{H}_2\text{SO}_4$ , Mn in soln. detd. colorimetrically.—CA.

**Determination of Nitrate in Drinking Water by Means of Diphenylamine.** RENATO ISIDORO. *Boll. Lab. Chim. Provinciali (Ital.)*, 2:16 ('51). The method is based upon the length of time required by the sample to attain a color matching a standard after treatment with diphenylamine sulfate. This lapse of time is shown to be proportional to the  $\text{NO}_3^-$  content of the sample. Less than 3 mg/l cannot be estd. To make the reagent, dissolve 0.050 g diphenylamine in 140 ml 80%  $\text{H}_2\text{SO}_4$  and add 2 ml 0.10 N HCl. For each test add 5 ml reagent to 0.5 ml water, mark the time, shake, and note the time the color matches Hellige disk No. 17478 for thymol blue. The time required was 880 sec for 0.0050 g  $\text{NO}_3^-$ /l and 65 sec for 0.020.—CA.

**The Influence of Nitrification on Biochemical Oxygen Consumption.** O. MALCHOW-MØLLER. *Ingeniøren (Den.)*, 59:886 ('50). A study of the reproducibility of present methods for the detn. of biochem. O consumption shows that application of the standard method, when used in different labs., may give widely varying results. Various suggestions for improvement are discussed. The modified method of Hurwitz, consisting of acidification to pH 3.0-2.0 followed by neutralization to pH 7.0-7.4, has been studied and compared with the standard method.—CA.

**Oxygen Determination by the Ferrrous Salt Method.** III. K. WICKERT & E. IPACH. *Vom Wasser (Ger.)*, 18:337 ('50-'51). An  $\text{Fe}^{++}$  soln. is

(Continued on page 44)

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prepd. by dissolving 50 g crystd.  $\text{FeSO}_4$  in 200 ml  $\text{H}_2\text{O}$  which has previously been treated with  $\text{CO}_2$ , and then adding 3 g powd. Fe and 3 ml 30%  $\text{H}_2\text{SO}_4$  or HCl. The  $\text{H}_2\text{O}$  sample to be tested is made to react with 0.3 ml of the  $\text{Fe}^{++}$  soln., 0.2 ml 50% NaOH, 5 ml 30%  $\text{H}_2\text{SO}_4$  or HCl, and 5 ml 10% KCSN soln. The Fe-thiocyanate color which develops is compared with a soln. of known Fe content. The method gives results comparable to the toluidine-thiocyanate method.—CA.

**Amperometric Titration of Silicates.** M. T. BERKOWITSCH. Zavodskaya Lab. (U.S.S.R.), 16:558 ('50). Results are described of investigations on the amperometric titration of silicates with a solution of lead nitrate in 0.1 N potassium nitrate. The method was found satisfactory for amounts of 0.5–0.01 mg of silica. Sulfates were found to interfere with the determination but not chlorides in concentrations up to 10 times that of the silica. In the presence of carbonate, the titration should be carried out in neutral or slightly acid solution. Alkaline solutions were heated with hydrochloric acid and phenolphthalein till colorless, then restored with 1–2 drops of alkali to the original normality. Silicates were fired with sodium potassium carbonate, dissolved in water, filtered, heated, mixed with phenolphthalein, and treated as already described.—WPA.

**Colorimetric Determination of Silica in Natural Waters. II.** FUMIO AOKI. J. Chem. Soc. Japan, Pure Chem. Sec., 72:15 ('51). The interfering substances of the silicomolybdic acid method are reducing substances (such as  $\text{HS}^-$ ,  $\text{Fe}^{2+}$ ,  $\text{Fe}^{3+}$ , and  $\text{PO}_4^{3-}$ ). The effect of phosphate can be removed by the addn. of tartaric acid which decomp. the phosphomolyb-

dic acid. Fe can be removed by cation exchange. The sensitivity of the method can be increased by detg. the blue color of Mo blue which is formed by the reduction of yellow silicomolybdic acid. As the reducing agent the following mixt. is recommended: 15 g of anhyd.  $\text{Na}_2\text{SO}_3$  and 1 g of hydroquinone are dissolved in 70 ml of water which is boiled to expel O and this is dild. to 100 ml after addn. of 1 drop of  $\text{H}_2\text{SO}_4$  (1:1). This reagent can be stored for 3 weeks in a dark place. **III. Ibid.**, 17. Changes of silica value in Na silicate soln. detd. by the above method are studied under various conditions of pH, temp. In neutral soln. contg. more than 200 mg  $\text{SiO}_2$  per liter the decrease of  $\text{SiO}_2$  value with the time after the prepn. of the soln. is large, whereas in a soln. contg. 120 mg  $\text{SiO}_2$  per liter the decrease is not so large, either in acid or neutral soln. The possibility is discussed of the existence of colloidal silica which is not detd. by the silicomolybdic acid method.—CA.

**A Method of Estimating Sulfides in Waters.** J. E. HOULIHAN & P. E. L. FARINA. Sew. & Ind. Wastes, 24:157 ('52). The method consists of: [1] detg. total I adsorption by using Winkler reagents; [2] expelling  $\text{H}_2\text{S}$  with N from a blank; [3] detg. I absorption by blank; and [4] computing sulfides from formula  $0.4(x - y) = \text{S}^-$  (ppm) when 500-ml sample is used and  $x = \text{ml } 0.0125 \text{ N I absorbed by sample}$  and  $y = \text{ml } 0.0125 \text{ N I absorbed by blank}$ .—CA.

**Conductimetric Titration of Sulfate Ions in Water.** E. A. QUEVEDO. Rev. Obras Sanit. Nac. (Arg.), 14: 99 ('50). Modifications are described in the procedure for conductimetric titration of sulfates in natural waters proposed by Polsky. The modified method permits direct detn. in the

(Continued on page 46)



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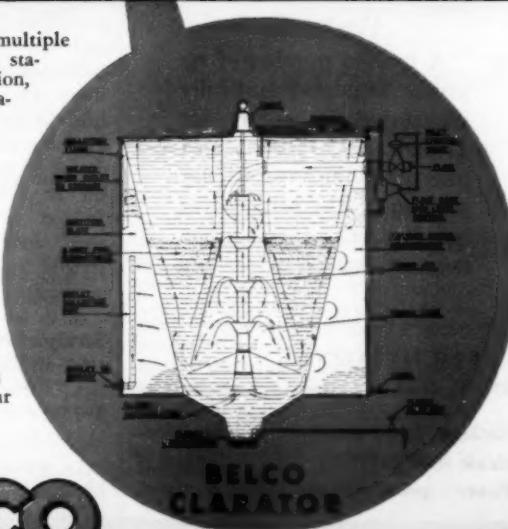
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(Continued from page 44)

range 0-80 mg per liter. In concns. greater than 10 mg per liter, this method has been found to agree to within 3.9%, with results obtained by the gravimetric method; with concentrations less than 10 mg per liter, results agreed to within 9.1% on an average though discrepancies up to 30% were noted.—WPA.

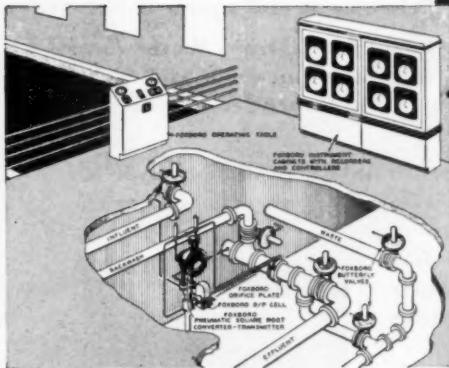
**Use of Commercially Available Portable Survey Meters for Emergency Fission Products Monitoring of Water Supplies.** J. B. HURSH, S. Zizzo, & A. H. DAHL. Atomic Energy Projects, Univ. of Rochester, (UR-180) 32 p. (Aug. 3, '51). As a result of tests using six commercially available survey meters of the thin side-wall G-M tube,  $\gamma$ - or  $\beta$ -detecting type, it was found that such an instrument had a sensitivity range which made it usable for emergency  $\beta$  monitoring of water contam'd. by fission products. A convenient measurement kit has been assembled consisting of an 8-oz metal container for the water to be tested and two calibration standards with the radioactive material distributed on the inner surface of duplicate container lids. These standards are adjusted to give the same meter deflection as produced by mixed fission products in water at concentrations (3.5  $\mu$ c/liter) judged safe for 10-day consumption, and concentrations (90  $\mu$ c/liter) judged an acceptable risk for 10-day consumption, respectively.—PHEA.

**Study of Natural Waters by Adsorption on Hydrosols.** C. COHN. Ann. Sta. Centr. Hydrobiol. Appl. (Fr.), 3:185 ('50). It is possible to conc. suspended matter present in water in very small amounts by adsorption on hydrosols of thorium oxide or arsenic sulfide which can then be pptd. with magnesium sulfate. The ppt. is centrifuged and the colloid dissolved with acid or alkali. The hydrosol to be

(Continued on page 50)

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This cast iron water main installed in Alexandria, Virginia, 100 years ago is still rendering satisfactory service. Over 35 other American cities have century-old cast iron mains in service.



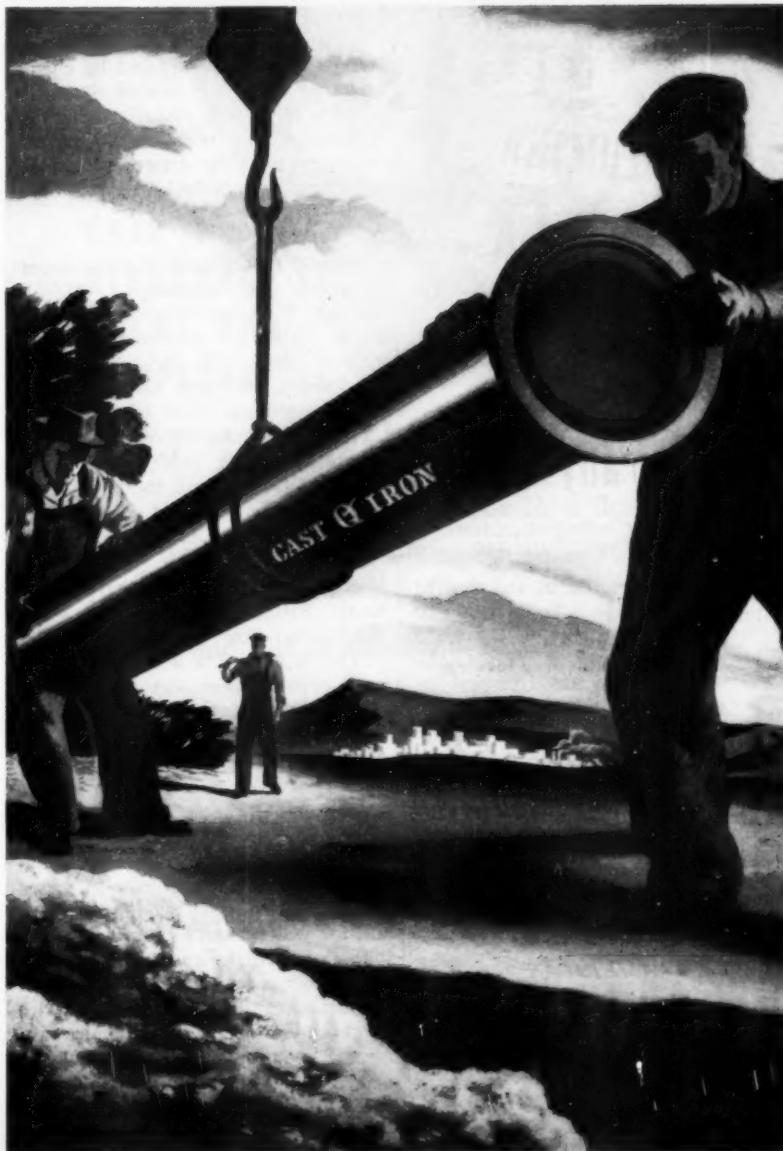
## CAST IRON PIPE

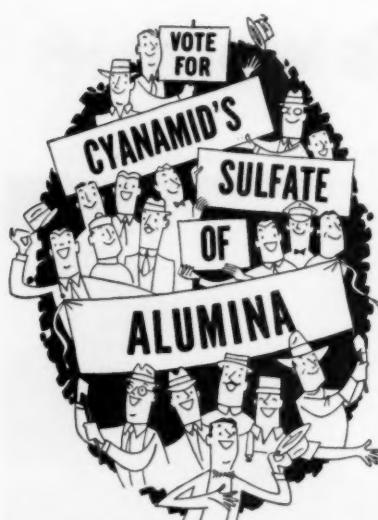
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(Continued from page 46)

used should be chosen according to whether the material to be examd. is sensitive to acid or alkali. The application of this method to the study of samples of water from the Seine and from the water supply of Paris is described. The deposit obtained can be studied microscopically and by chemical analysis. With thorine it may be possible to identify visually the nature of the deposit by its color. The method is also suitable for detecting traces of heavy metals such as lead, copper, and iron.—WPA.

**Chemical Analysis of Water—Interpretation of Findings.** M. L. MUNDY, WILLIAM BURNS, & THOMAS L. A. SAMUEL. Munic. Eng. Sanit. Record (Br.), 127:258 ('51). The usual detns. are listed, and methods of analysis outlined. The significance of high O, the presence of nitrates and nitrites, ammonia, hardness, poisonous metal limitations, and the phys. characteristics of the water being tested are considered.—CA.

**Microchemistry in Water Analysis.** KARL STUNDL. Mikrochemie ver. Mikrochim. Acta (Aust.), 36/37:927 ('51). A review in which the importance of microchem. tests to the biologist is pointed out.—CA.

**Applications of Color Electrophotometry in Water Chemistry.** J. L. DE HAUSS. L'Eau (Fr.), 38:195 (Dec. '51). A comprehensive review of the latest uses of color electrophotometry for pH measurements for sea water and many industrial products, and for water analysis is given. The following detns. can be made with satisfactory quantitative accuracy, after production of characteristic colors with appropriate standardized chemical reagents: organic matter, dissolved oxygen,  $\text{NH}_3-\text{N}$ ,  $\text{NO}_2-\text{N}$ ,  $\text{NO}_3-\text{N}$ , pH,  $\text{SiO}_3$ ,  $\text{Fe}^{2+}$ ,  $\text{Al}^{3+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{K}^{+}$ ,  $\text{Na}^{+}$ ,  $\text{SO}_4^{2-}$ ,  $\text{Cl}^{-}$ .

(Continued on page 52)

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FOR BETTER WATER SERVICES

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(Continued from page 50)

The speed and accuracy of these procedures render them particularly desirable for checks on boiler and process waters.—*M. Albanese*.

**Reporting, Interpretation, and Utilization of Water Analyses.** I. I. CHEBOTAREV. *Wtr. & Wtr. Eng. (Br.)*, **56**:132 (Apr. '52). Following modes of reporting occur in practice: [1] In oxides, anhydrites, and haloids; [2] In grains per Imp. gal; [3] In grains per U.S. gal; [4] In parts per 100,000; [5] In ppm; [6] In g per liter; [7] As assumed composition of salts; and [8] As hardness of water. Attempt to bridge gap in reporting is well-timed. Chief constituents usually detd. when chem. characteristics of water are desired are:  $H^+$ ,  $Na^+$ ,  $K^+$ ,  $Ca^{++}$ ,  $Mg^{++}$ ,  $Al^{+++}$ ,  $Fe^{++}$ ,  $Mn^{++}$ ,  $NO_3^-$ ,  $Cl^-$ ,  $SO_4^{--}$ ,  $HCO_3^-$ ,  $CO_3^{--}$ , and  $OH^-$ . Oxides, anhydrites, and haloids give results of water analysis in state of chem. combination of positive ions dissolved in water with oxygen, such as  $Na_2O$ ,  $K_2O$ ,  $CaO$ ,  $MgO$ , and in form of anhydrites such as  $SO_3$ ,  $N_2O_5$ , and  $N_2O_3$  for the negative ions. Ionic form of reporting gives simple list of chem. elements revealed in water and measured by weight. Reacting values show proportional reaction capac. of radicals. Molecular form presents result of dividing value of ions reported by their atomic weight. Equivalent form can be computed from molecular mode by multiplying valency of ion. Usually, however, equivalent mode is obtained from ionic mode by multiplication of ionic magnitudes by reaction coefficient. When reacting values of ions are given as percentage of total salt content, comparison of rate of each ion reported in reacting values as well as interpretation of data are facilitated. There are two modes for expression of chem. composition of water in assumed salts. One is based on Bensen-Fresenius concept regarding

reactive capacity of acids and relative solubility of salts. Ions of strong acids form chem. combination with alkalies and remainder of acid radicals gives combination with alkaline earths. Second mode is based on assumption that, at first, alkaline earths form combination with weak acids, and if there is excess calcium it is assigned to sulfate as  $CaSO_4$ , and the remaining calcium should be reported as  $CaCl_2$ . Magnesium is interpreted in same way. Both of these methods can be considered as arbitrary. Hardness is expressed in so-called degrees of hardness among which are distinguished English, French, and German. Accepted British practice is expression of hardness in English degrees or in ppm. Ionic and equivalent forms of reporting water analyses can be considered most suitable for practical purposes, particularly if results are expressed in ppm.—*H. E. Babbitt*.

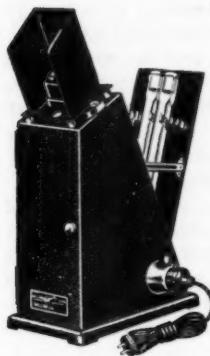
## DISTRIBUTION SYSTEMS

**Prestressed Concrete Pipes.** G. A. OOKAAS. *J. Inst. Civ. Engrs. (Br.)*, **6**:85 (Mar. '52). Use of prestressed concrete is justified for 40 in. diam. pipe for max. working bursting pressure of 50 psi. This means saving of 70 to 80% of reinforcing steel. Price of high-tensile steel necessary for making prestressed pipe, however, is approx. twice as high as that of mild steel. Concrete is also of high quality but wall thickness can be considerably reduced. Technical advantages lie in possibility of using concrete pipe in which, when loaded by max. internal water pressure and external loads, no tensile stresses will occur in concrete and max. impermeability of pipe will be obtained. Life usually assumed is 50 yr. Distinctive and most complicated part of each pipe is joint construction. Discontinuity between prestressed body and non-prestressed end causes trumpetlike de-

(Continued on page 54)

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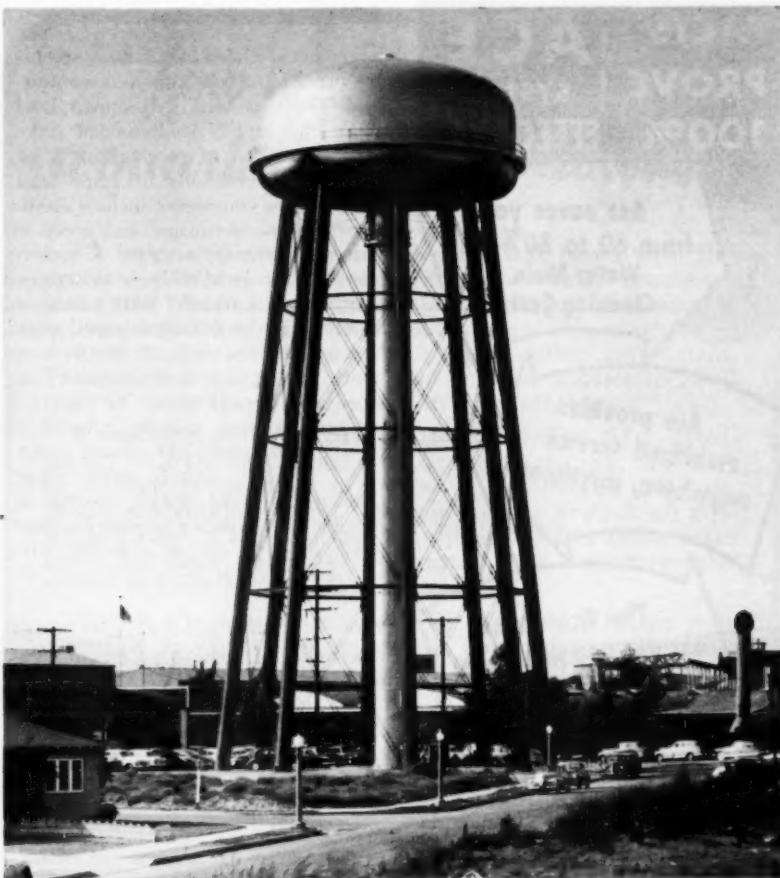
**American Water  
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(Continued from page 52)

formation and secondary bending moments in this part of pipe wall. Pipe systems can be classified according to method of their construction as "monolyte" (pipe wall cast in one piece), sometimes called Freyssinet or Sentab, and construction in two stages. Inner concrete core of pipe is formed by centrifugal process in steel mold. After thorough hardening period, high-tensile steel wire is wrapped round core under high tension. Core is thus prestressed at approx. 2000 psi. It is then covered by coating. Some types of pipe are fitted with steel cylinder which eliminates longitudinal prestress. When no steel cylinder is used, longitudinal, high-tensile wires are pretensioned, and concrete is prestressed in all directions. In Freyssinet pipe it is cast between two special molds covered with rubber jacket, latter being protected by flexible steel coat composed of steel strips separated by thin rubber layers. Outer mold is formed by series of I-beams upon which complex of wooden ribs and slats is mounted. Manufacture of Sentab is similar, in principle, to that of Freyssinet pipe. Socoman pipe is made with pretensioned circumferential and longitudinal reinforcement, with cast-iron joint rings. Watertightness between cast-iron and concrete is secured by pressure. Sealing element between bell and spigot is rubber gasket shaped like partly split wedge. Bonna prestressed pipe is manufactured in two styles, one with and other without steel cylinder. Bell-and-spigot rings are constructed of heavy steel strips on which steel cylinder or thin steel plate is welded. Further mfg. processes are similar to Socoman pipe. In Socol pipe, longitudinal wires are post-tensioned. After curing of core, bars are tensioned and anchored by nuts. To provide necessary movement wires are wrapped in thin metal sheet. There is pretensioned secondary rein-

(Continued on page 56)



## *Fourth Elevated Tank at South Gate*

The City of South Gate, Calif., recently installed the fourth Horton elevated steel tank, a 500,000-gal. radial-cone structure shown above, in its water distribution system. The tank was designed for a 12 per cent earthquake factor and, as a result, was built with inclined columns supporting the tank and double diagonal rods between the columns.

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(Continued from page 54)

forcement intended to eliminate secondary bending stresses due to discontinuity. There is also well-known Lock Joint Pipe and N.V. Betondak Arkel Pipe, a variant of Lock Joint Pipe. In static calculations for pipe wall, factors to be considered include elastic deformations, shrinkage and creep of concrete, and creep in steel. Extensive formulas for each of these are given. Coating is important. With exception of Freyssinet and Sentab pipes, coatings are applied without prestressing which may give rise to difficulties as, when pipe is subjected to internal pressure, tension will be induced in coating and cracks are almost inevitable. Difficulty can be partly overcome by applying coating as soon as possible after winding process has been finished or by use of concrete with very low modulus of elasticity.—H. E. Babbitt

**Corrosion of Asbestos-Cement Water Mains.** H. BOORSMA. Bul. Centre Belge Étude et Document. Eaux (Liège), 1:11:9 ('51). Corrosion of asbestos-cement water mains was encountered when the usual well-water supply was supplemented by condensate from the salt works. This condensate contained variable amounts of  $\text{CO}_2$  and was unsatd. with respect to  $\text{CaCO}_3$ . This water was rendered noncorrosive by adding a limited quantity of the purified well water with its higher Ca content.—CA

**Waters and Soils With Detrimental Chemical Effects on Asbestos-Cement Pipes, and the Prevention of These Effects.** GYULA SZIGLIGETI. Hidrol. Közlöny (Hung.), 30:43 (50). Asbestos-cement and asbestos-concrete pipes mfd. from portland cement can be used if the water and the soil content of sulfate is below 300 mg/l. When the sulfate content exceeds this value, protective coatings (various bitumen emulsions) should be used on

(Continued on page 58)

## how to save... a quarter million dollars

A large mid-western city recently was faced with this problem. Within eight years after the water treatment plant was placed in operation, the submerged steel showed active corrosion of alarming proportions — the warning of a possible loss of a quarter million dollar investment. Various coatings were tested for possible application, but none of those tested was considered satisfactory.

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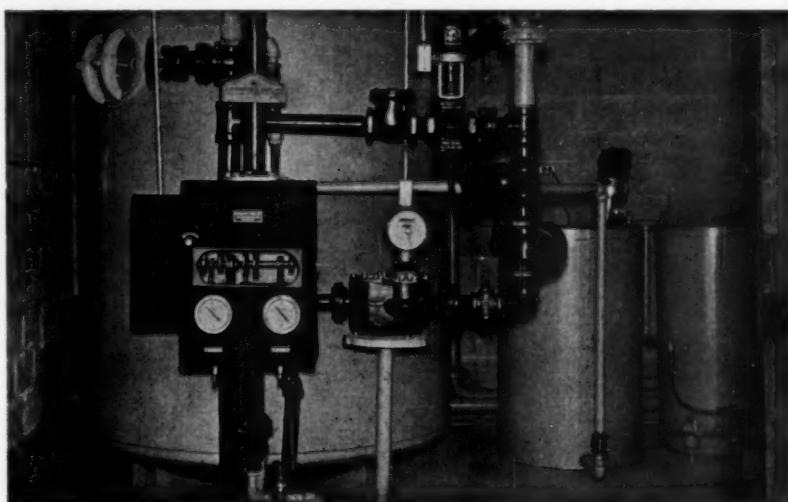
(Continued from page 56)

pipes prep'd. from portland cement, or sulfate-resistant (Ferrari-type) cement must be used in the manufacture of the pipes.—CA

**Fighting Leaks With Pressure Reducers.** ANON. L'Eau (Fr.), 38:10 (Jan. '51). The 143 townships of the Parisian region are grouped in a water supply syndicate served by 3480 mi. of mains; losses amount to 30% of original supply as follows: 5% for exploitation needs, 10% as result of faulty meter operation, and 15% on the network itself, of which leaks in small distribution mains represent 90%. Two methods are used to eliminate such losses: methodical locating of leaks by squads of 1 foreman and 2 helpers. During daytime, simple

acoustic canes are used. Frequency of rounds varies between 15 days and 1½ yr. Other public service employees (electricity, sanitation, gas) help. Pressure reduction decreases water hammer, stress on joints and elbows, and leaks. Big mains are doubled for local distribution, reducing pressure from 135 to 64 psi (avg.). To regulate the pressure, surge suppressors are utilized, which compensate the high and variable hydrostatic load of big mains, as well as water hammer. Regulators are based on the principle of adjustable spring-controlled valves enacted by the water flow; good surge suppressors are robust, simple, needing only rare and easy maintenance, are preferable to bulky and expensive air chambers, and are readily avail-

(Continued on page 60)



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(Continued from page 58)

able. They can be used in hilly regions, on extended mains, on derivations between pumping stations, and on reservoirs. Reductions of 57% in network leaks (0.91 mgd) have been observed in one year at Ivry, near Paris, following the installation of one surge suppressor.—*M. Albanese*

**Some Problems Concerning the Distribution of Water.** G. W. COVER, ET AL. *J. Inst. Wtr. Engrs. (Br.)*, 6:110 ('52). Reinforced lead pipes seem to have advantages, but should be tried over a long period. Wiped soldered joints are generally superior for pipe couplings. There are many alternative methods for protecting storage tanks from rust. The use of steel and iron tanks may be the best in the long run, unless the nature of the water is known to be aggressive to ferrous metals. Two substances from which plastic tubing can be made for domestic purposes are polymerized ethylene (polythene) and polyvinyl chloride. These materials have advantages and disadvantages when compared with other materials.—*CA*

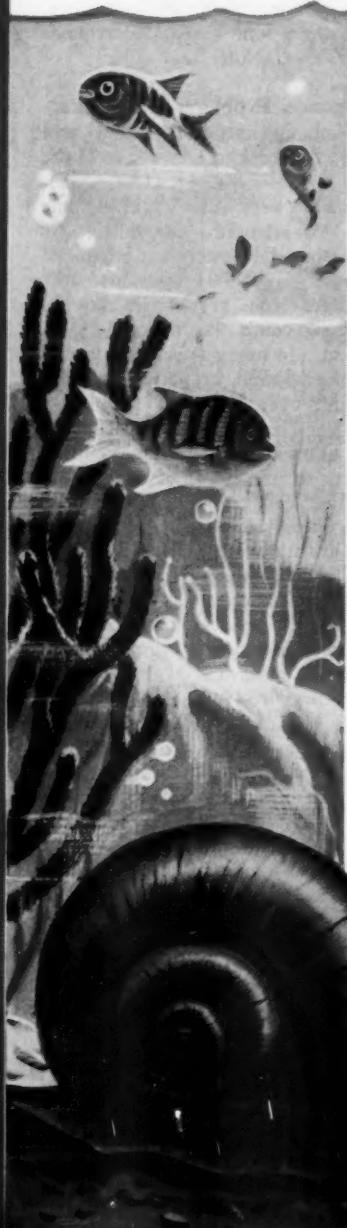
**Waterworks Valve Maintenance and Repair in the City of Peterborough (Ont.).** Ross L. DOBBIN. *Munic. Util.*, 89:24 (Aug. '51). Little maintenance possible during 10-yr period. In '50, valve crew (foreman, 1 hydrant operator, 2 valve operators, and 2 laborers) assigned exclusively to valve repair. City divided into 6 areas, each contg. approx. 200 valves, work in each area being completed in turn. Procedure outlined. After main valves checked and necessary repairs made, hydrant valves and private service valves over 2" diam. examd. and hydrants packed and greased. Valve faults found, in order of frequency: faulty packing, plugged valve post, broken or damaged spindle. When excavation necessary, valve repacked

whether needed or not. Stranded, tallowed hemp packing, lubricated with graphite and oil, used exclusively. Crew could test 30-40 valves per day. Card index made of location, date of operation, condition, etc. Valves checked—1098, repaired—55 (50 bent spindles), packed—153, excavated—111, flushed—29. Hydrants checked—525. Total cost \$8425 of which \$7840 for labor. Cost of repairs per valve \$7.67.—*R. E. Thompson*

**V.H.F. Radio Communication Equipment for Water Undertakings.** A. A. SMITH. *J. Inst. Wtr. Engrs. (Br.)*, 5:605 (Oct. '51). There are only 4 water supply authorities in England licensed to use radio communications equipment. These users are unanimous in acclaiming the usefulness of radio communications equipment in water works. This paper deals mainly with the equipment of South Staffordshire Water Works Co. Buyer should have elementary knowledge of usable types of transmission. Two forms of modulation of carrier wave available are amplitude (AM) and frequency (FM) modulation. AM is most commonly used. Advantage of FM is great reduction of noise, including all unwanted signals. If two or more signals are present at received demodulator stage, strongest signal takes control to complete exclusion of others. AM communication can be effected within narrower band width. Direct point-to-point transmission consists of transmitter and receiver at each point employing common aerial. Called Simplex system, only one frequency is used and communication is possible in only one direction. Duplex operation requires two frequencies and permits conversation in both directions. This system is essential if used in conjunction with telephone system. If distance or hills interpose between receiver and transmitter, relay station

(Continued on page 62)

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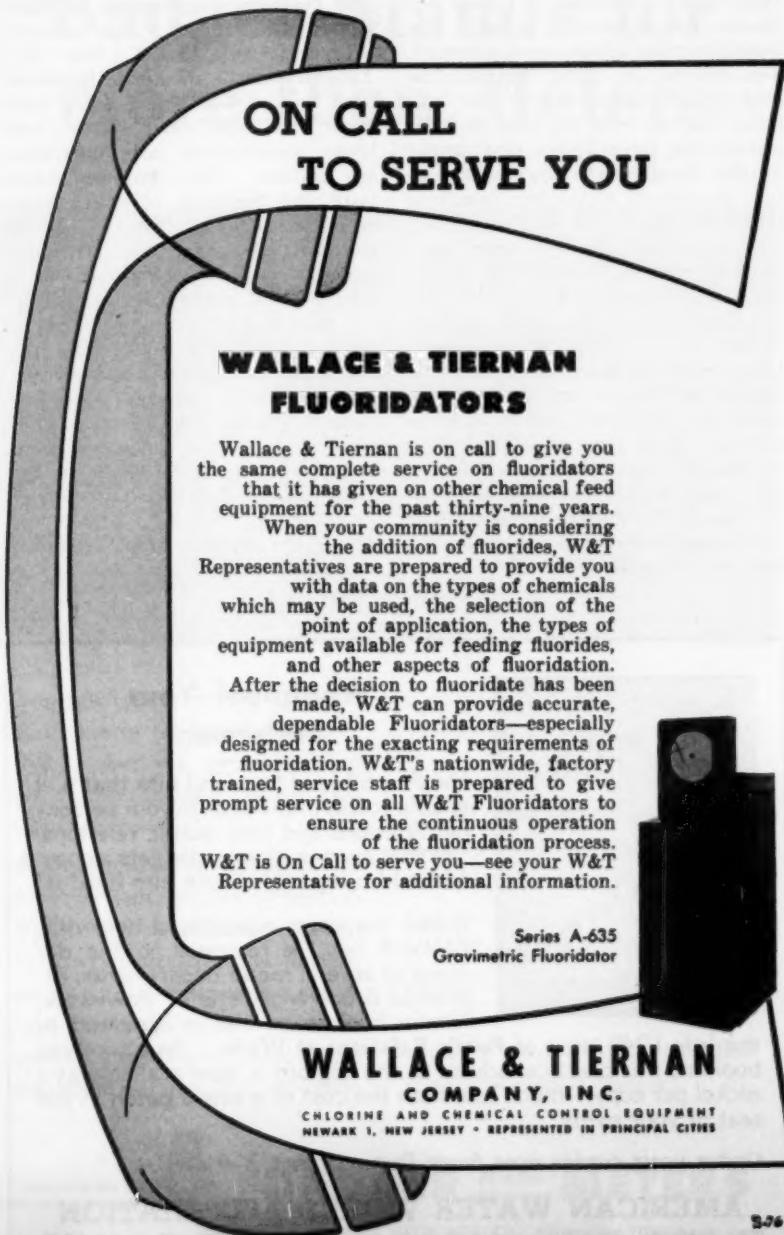
may be needed. Using Duplex operation of relay link, two transmitters and two receivers are required at relay station, doubling outlay on equipment, and requiring four operating frequencies.—H. E. Babbitt

**Maintenance Problems in Connection With Saskatoon's Water and Sewage Systems.** CLIFFORD HAW. Munic. Utils., 89:24 (Oct. '51). Mains and sewers usually laid in same trench. Maintenance carried on by same personnel. Sewers and mains 88 mi., services 10,800, hydrants 760. Soil ranges from very hard clay, in some areas contg. large boulders, to quicksand. In many areas, soil highly alk. In quicksand, cradle of dry concrete built over full width of trench and at least half way up pipe. Consumers allowed to leave taps running in winter to prevent freezing: during last winter, 500 taps open. Frozen services thawed electrically. City bears cost of first thawing and tap left running. If tap shut, subsequent thawings charged to consumer. Cost \$5.50. Galvanized Fe services have comparatively short life; when failure occurs, replaced by either Cu or Pb. Mains largely cast iron; in recent years, Transite pipe used extensively where soil conditions favorable. Graphitization principal cause of cast-iron pipe failure, after more than 30 yr. service. Hydrants inspected twice weekly during winter and flushed in spring. Steam boilers mounted on trucks used for thawing. Inspection of valves at least yearly planned. New mains chlorinated.—R. E. Thompson

## HEALTH AND HYGIENE

**Biological Warfare and Water Supplies.** V. B. LAMOUREUX. Southwest W.W. Jour., 33:4 (Dec. '51). A discussion of biological warfare and its effects upon the water industry. Methods of dispersion of bacteria by open or subversive warfare are discussed.

(Continued on page 64)



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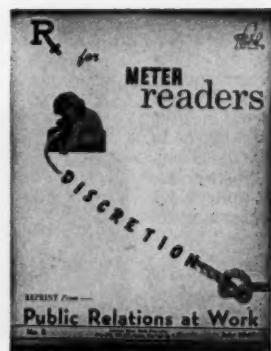
(Continued from page 62)

Waterborne organisms or toxins that deserve consideration as possible biological warfare agents are enumerated. Ten criteria are listed that may be used in designating agents for bacterial warfare. On the basis of these criteria the three agents that appear to offer the greatest chance of success in a waterborne attack are: botulinus toxin, leptospira, and bacillary dysentery organisms. Normal water purification practices diminish the probability that contamination added to the source of supply will reach the population served by the distribution system. Open reservoirs are subject to attack during open warfare and especially by saboteurs. Strengthening of existing defenses rather than reliance on new or unknown devices must be the defense against bacterial warfare. Role of Federal Civil Defense Admin. in distributing information on biological warfare is discussed.—PHEA

**The Hygienic Importance of Hard Water.** H. HöLZL. Gas, Wasser, Wärme (Aust.), 5:298 (Dec. '51). Taste of water is affected by hardness; hard and medium hard water taste better than soft water (flat); with lower temperatures taste differences are smaller. The consumer lumps taste and freshness together; hence cool spring waters taste good, but stored water has flat taste. Dissolved gases affect taste as well as type of salts present. Standards allow greater salt tolerances than those occurring in natural waters. Claims made that hard waters affect calcium transformation, vitamin D utilization, and hormone production are incorrect. Soft water, under certain conditions, causes calcium shortage. Hard water temporarily affects digestion.—W. Rudolfs

**The Fight Against Schistosomiasis.**  
NELSON BIAGGI. Puerto Rico J. Pub.

(Continued on page 66)



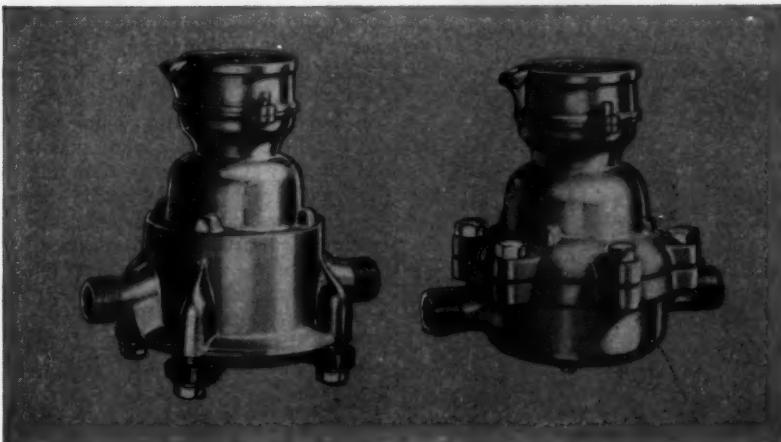
the July 1949 issue of **Public Relations at Work**. As a six-page booklet, this practical advice to the doglorn is now available at a nickel per copy—much less than the cost of a single patch in the seat of your pants.

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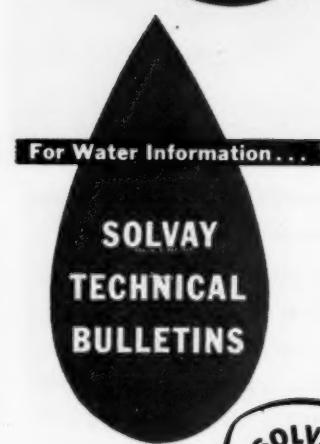
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(Continued from page 64)

Health Trop. Med., 26:101 ('50). A report is given on the treatment of waters destined for public use, treatment of sewage, sanitary disposal of feces, and the biol. and chem. attack on the snail (molluscicides).—CA

**Protective-Coating Formation on Lead and Lead Poisoning of Drinking Water.** JOHANNES MULLER. Gas-u. Wasserfach (Ger.), 92:4:39 ('51). In different countries, widely varying limits of Pb in drinking water are permissible. In general, the Pb content of water is higher after standing in Pb pipes for 12 hr. or more, and decreases with flow of water. Solv. of Pb from the metal itself is most important with a new pipe; later, Pb compds. may also play a role. Pb solv. may be decreased by the formation of tightly adherent basic lead carbonate ( $PbO \cdot 2PbCO_3 \cdot H_2O$ ), but even this is slightly sol. There appears to be no fixed relation between the softness of the water and Pb attack. Changes in compn. of the water may cause soln. of a previously deposited protective coating, and erosion of Pb compds. may also play a role. Both dissolved and suspended Pb affect the toxicity of Pb to human beings.—CA

**The Public Health Significance of High Nitrate Waters as Cause of Infant Cyanosis and Methods of Control.** D. F. METZLER & H. A. STOLTENBERG. Trans. Kans. Acad. Sci., 43:194 ('50). The authors discuss the presence of nitrates in well water as the cause of methemoglobinemia in infants. It is suggested that the presence of nitrates in well water may be caused by seasonal leaching of top soil. Recommendations are made for controlling the construction and maintenance of wells, particularly in rural areas, to reduce the incidence of waterborne methemoglobinemia.—WPA

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(Continued from page 18)

**The welding rod ouija** described in these columns last July (P&R p. 10) seems now to be waving in all directions, locating not only all kinds of pipelines, but cables, coins, iron deposits, and even water—in springs, of course. Latest area of infestation appears to be Elizabeth, N.J., where, according to a front-page illustrated story, the delusion has attacked an electrical engineer and a host of public service, gas, and telephone men. Happily, not a water works man was stricken, and, as a matter of fact, not many miles away, in Livingston Manor, N.Y., a water works man was actually striking back, proving that the rods don't work at all when he takes his hat off. Which, now that the rods are proving themselves merely clumsier substitutes for the dowser's twig, leads us to say, "Hats Off" to the new diviner's designers.

**On the eerie and the unexplained** we could continue long, and, even sticking to strictly water wonders, we must call your attention to at least a seiche, a tremor, and a minor miracle.

Scene of the seiche was Lake Huron in the vicinity of Sarnia, Ont., and Port Huron, Mich. There, though the levels of all the Great Lakes have been rising steadily, causing millions of dollars of property damage with each foot of record height, the waters of Lake Huron suddenly receded some twenty to thirty feet at about sundown on July 24. "A seiche," the story said, "is described as an occasional rhythmical movement from side to side of the water of a lake with fluctuation in the water level, varying in duration from a few minutes to several hours." But if no one has yet complained, where did all those feet seiche to?

Condemner of the tremor was W. K. Perrett of Arlington, Tex., when geologists named it as the probable reason why his well water turned from icy cold to 115°F just when his thirst got worst. And yet an April tremor that can cause an overnight temperature change in mid-June by seeping hot water from depths of 3,000 to 4,000 ft into an 18-ft well seems almost more "Gee! Golly! Gee!" than geology.

Motivator of the minor miracle is our old New York reservoir friend and cloud buster, Dr. Wallace E. Howell of Harvard. No sooner had he been hired last July to rout the drought striking a group of Connecticut farmers than the heavens opened and gave the whole Northeast almost too thorough and prolonged a drenching. Having Nature almost too, too anxious to help him in his cloud seeding expeditions this way, Dr. Howell must be considered at least precipitation prone.

What price even water wonders—lake, well, or sky?

(Continued on page 70)

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(Continued from page 68)

**John O. Larson** has been appointed to fill the new post of executive vice-president for Fischer & Porter Co.

**Maurice H. Coblenz**, senior sanitarian (R) of the U.S. Public Health Service, has embarked for Jordan, where he will participate in public health activities of the Technical Cooperation Administration (Point Four).

**Lake Products Co., Inc.**, producer of the C-L-Two cleaner for chlorinating machines, has been moved to larger quarters at 1252 Grover Road, Lemay, Mo.

**Mathieson Chemical Corp.** is planning a merger with the well known pharmaceutical firm of E. R. Squibb & Sons. Under the plan approved by both boards and submitted to the stockholders, the Squibb firm will become a Mathieson division.

**Clyde E. Williams & Assoc.**, engineering firm of South Bend, Ind., is opening a new office in Indianapolis, at 612 Chamber of Commerce Bldg.

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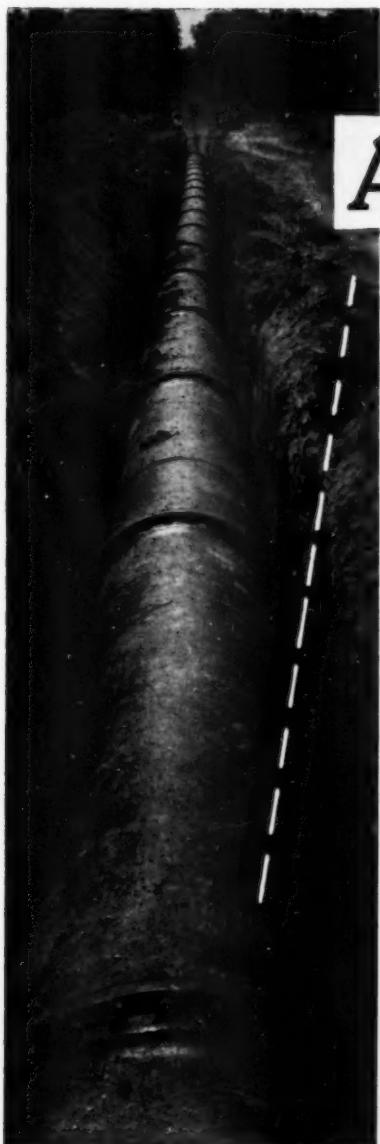
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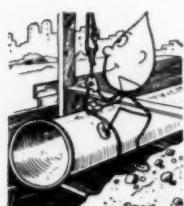
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## Committee Pipeline

● **Cast-iron pipe specifications:** New and revised American Standards for cast-iron pipe and fittings, under Chairman Wiggin and ASA Committee A21, have progressed to the stage at which final approval and publication are at last in sight. A report dated January 4, 1952, was published in the JOURNAL as an appendix to the Water Works Practice Committee's annual report (see March 1952, p. 261); further developments since that time are reported below:

*A21.1—Computation of Strength and Thickness.* Committee clearance of a new section to this existing standard is still awaiting approval of further data on pipe loads, the first draft of which has been prepared and is now being inspected.

(Continued on page 74)

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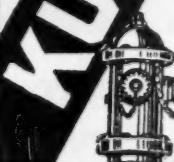


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(Continued from page 72)

*A21.2—Pit-Cast Pipe.* Committee A21 approved the revision to this existing specification on June 25, 1952. It is now before the various sponsors (American Gas Assn., American Society for Testing Materials, New England Water Works Assn., and AWWA) for their approval, after which it will be submitted to the American Standards Assn. for final adoption.

*A21.4—Cement-Mortar Lining.* Revisions to the existing specification have been approved by Committee A21 on April 21, 1952. Sponsor approval has been received so far from AGA (June 13, 1952), and AWWA (July 24, 1952). ASTM and NEWWA have still to act.

*A21.6—Pipe Centrifugally Cast in Metal Molds; and A21.8—Pipe Centrifugally Cast in Sand-Line Molds.* Approval by Committee A21 of both these new specifications was received on April 30, 1952, and they are now before the sponsoring organizations for their approval.

*A21.10—Short-Body Fittings.* Final sponsor approval has been obtained for this specification and the approved text was submitted to ASA on April 18, 1952. It is anticipated that formal adoption, which will be followed by publication in the JOURNAL, is imminent.

*A21.11—Mechanical Joints.* This document was approved by Committee A21 on June 30, 1952, and has been submitted to the sponsors for their approval.

● **Air conditioning:** An appeal for information about communities that have adopted special rates or regulations for the use of water in air conditioning has been made by the chairman of AWWA Committee A1.C—Water Use in Air Conditioning and Refrigeration. The committee, which has already drawn up a model ordinance (see December 1950 JOURNAL, p. 1111), wishes to maintain a complete file of such regulations. The information, together with official copies of the regulations, if obtainable, should be sent to Frank C. Amsbary Jr., Vice-Pres. & Secy., Northern Illinois Water Corp., 122 N. Walnut St., Champaign, Ill.

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### *The Reading Meter*

(Continued from page 20)

**Microbiology of Water and Sewage.** *P. L. Gainey & Thomas H. Lord.* *Prentice-Hall, Inc., New York (1952) 430 pp.; \$7.85*

Intended as a classroom textbook for students who may have limited backgrounds in biology or chemistry, this thorough study of organisms to be found in water and sewage should also prove useful to those water works operators whose knowledge of this aspect of sanitary engineering may need codifying. The various types of organisms encountered, their significance and possible effects, as well as the effect upon them of environmental changes and water treatment, are all carefully discussed. It is hardly a material point, but it is somewhat puzzling to see, in this as in so many other recent studies, how little note has been taken of the explanation advanced by Green and Stumpf for "The Mode of Action of Chlorine" (see November 1946 JOURNAL). Such minor theoretical lapses do not detract from the essential worth of a solid and readable study, however.

**Dictionary of Architecture.** *Henry H. Saylor.* *John Wiley & Sons, Inc., New York (1952) 221 pp.; \$4.50*

Those who cannot tell a mullion from puncheon, but want to, will find this little glossary a useful aid. A section of drawings offering illustrations of certain architectural styles, and the inclusion of definitions of the materials as well as the elements of building adds to the usefulness of this reference work.

**Quality and Treatment of Water in the West.** *Ray W. Hawksley.* *Western Industry, 503 Market St., San Francisco 5, Calif. (1950) 20 pp.; paperbound; 50¢*

This compilation of articles reprinted from *Western Industry* is aimed at the industrial plant manager who is relatively inexperienced with water supply and treatment problems. In addition to giving a bird's-eye view of the possibilities and pitfalls in water treatment, the booklet includes summary analyses of the water supplies of almost 1,000 cities in the states of California, Oregon, Washington, Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming. The information supplied is variable, and ranges from the total hardness as  $\text{CaCO}_3$  for Wyoming cities to more detailed mineral analyses for other states.

(Continued on page 78)



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*(Continued from page 76)*

**Studies on Household Sewage Disposal Systems. Part II.** *T. W. Bendixen, M. Berk, J. P. Sheehy, & S. R. Weibel. Environmental Health Center, Public Health Service, 1014 Broadway, Cincinnati 2, Ohio (1950) 94 pp.; paperbound; single copies free to health officials and others in this field; additional copies 55¢ from Supt. of Documents, U.S. Government Printing Office, Washington 25, D.C.*

This report is the second of a projected series, as yet incomplete, on research that was initiated in 1947 by the Housing and Home Finance Agency and the Public Health Service. The subject matter covered by the present report includes compartmentation of septic tanks; inlets, outlets, and intercompartment appurtenances; percolation test methods; field surveys and permeability conditions of absorption systems; and soil clogging effects of septic tank effluents. Of interest is the estimate that 17,000,000 persons in the U.S. are served by residential septic tank systems that work on the soil absorption principle.

**Corrosion Testing Procedures.** *F. A. Champion. John Wiley & Sons, Inc., New York (1952) 369 pp.; \$6.25*

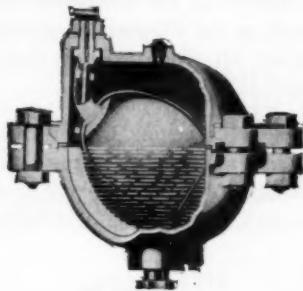
A thoughtful study of even the minutest details of corrosion testing procedures, such as this monograph obviously provides, should be a useful aid to their standardization and the yielding of reproducible results. Among topics covered are the selection and preparation of specimens, corrosion media, laboratory exposure conditions, field and service tests, postcorrosion cleaning methods, and interpretation of results. Clearly the book should be a valuable aid to future corrosion tests.

**The Water Resources of Clark County, Ohio.** *Stanley E. Norris, William P. Cross, Richard P. Goldthwait, & Earl E. Sanderson. Bul. 22, Div. of Water, State Dept. of Natural Resources, Columbus, Ohio (1952) 82 pp.; paperbound; free*

The region surveyed is in west-central Ohio and includes the industrial city of Springfield, which accounts for more than 78,000 of the county's population of 111,000.

*(Continued on page 80)*

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## *The Reading Meter*

(Continued from page 78)

**Water Resources of Virginia.** *Report of the Committee on Water Resources to the Advisory Council on the Virginia Economy. Div. of Planning & Economic Development, 310 State Finance Bldg., Richmond 19, Va. (1952) 142 pp.; paperbound; free*

This report on Virginia's water resources begins with rainfall (12 in. above the national average of 30 in.) and studies in turn surface and ground water supplies, flood control, wastes and pollution, and agricultural and industrial uses, including irrigation and water power.

**Great Basin Drainage Basin:** *Summary report on water pollution. Water Pollution Series, No. 4; Public Health Service Pub. No. 82. Div. of Water Pollution Control, Public Health Service, Washington, D.C. (1951) 67 pp.; paperbound; free*

The Great Basin in Nevada, Utah, California, Idaho, and Wyoming is comprised of 184,000 square miles of predominantly desert area, with annual precipitation ranging from zero in the south to a maximum of 5.5 in. in the north. The population of 938,000 is centered near available water sources, and these are expected to govern any future growth. Despite the low population density, pollution is still a problem, which the scarcity of water emphasizes. It is a credit to those responsible that, although only 58 per cent of the sewerized population is served by waste treatment plants, and only 17 per cent adequately, on a basin-wide count; all of 100 per cent of the sewerized population in the Owens River Sub-basin is adequately served.

(Continued on page 82)

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**KOPPERS COMPANY, INC., Tar Products Division, Dept. 905T, Pittsburgh 19, Pa.**

District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh, and Woodward, Alabama

## *The Reading Meter*

*(Continued from page 80)*

**Upper Mississippi Drainage Basin: Summary report on water pollution.** *Water Pollution Series, No. 15. Div. of Water Pollution Control, Public Health Service, Washington, D.C. (1951) 81 pp.; paperbound; free*

The basin surveyed has a population of 16,500,000 in eight north-central states. In general, the water resources are abundant, but in some areas a receding water table has made the pollution of surface supplies especially serious. To this pollution, municipalities are the principal contributors; yet of 1,432 sewered communities serving 10,400,000 persons, over 1,000 have treatment facilities serving 8,390,000 persons. Many need additional capacity, however, and many more need to be built.

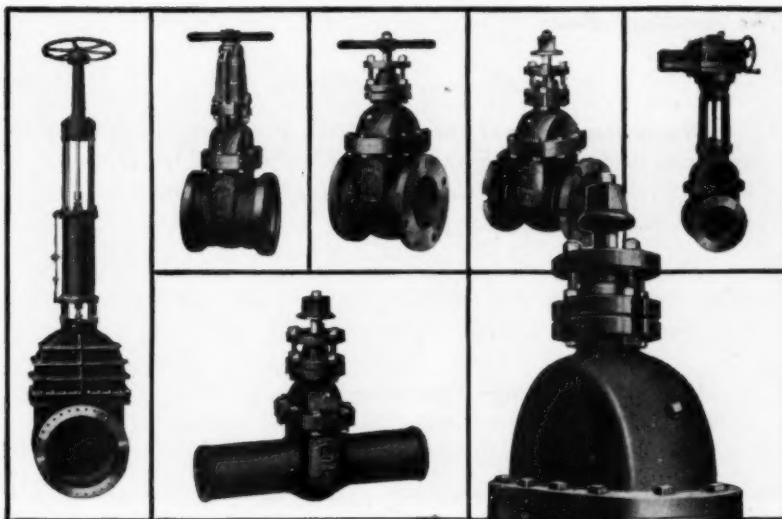
**Missouri River Drainage Basin: Summary report on water pollution.** *Water Pollution Series, No. 3; Public Health Service Pub. No. 78. Div. of Water Pollution Control, Public Health Service, Washington, D.C. (1951) 212 pp.; paperbound; free*

The Missouri, longest of North America's rivers, drains one-sixth of the United States—the watershed lying in ten states and housing 8,200,000 people. Although stream pollution is not generally serious, there are local problems that are acute, and the 53 per cent of the sewered population served by some sort of sewage treatment is below the national average of 62.7 per cent. Although 52 per cent of the municipalities in the region have adequate treatment plants, the failure of the larger cities to provide them means that only 18 per cent of the basin's sewered population is adequately served.

**Planning and Making Industrial Waste Surveys.** *Metal-Finishing Industry Action Committee, Ohio River Valley Water Sanitation Com., 414 Walnut St., Cincinnati 2, Ohio (1952) 46 pp.; paperbound; \$1*

Another constructive addition to the antipollutional literature, this manual offers concrete advice to industries for planning and conducting studies of their liquid wastes. Methods of measuring flow, taking of samples, calculating the waste load, and general information are described in detail.

*(Continued on page 84)*



## KENNEDY A.W.W.A. GATE VALVES

### JOB-FITTED

**...for a wide range of  
water works requirements**



KENNEDY Fig. 56,  
A.W.W.A. Standard  
Double-Disc Gate Valve

Every KENNEDY A.W.W.A. valve job is JOB-FITTED . . . specially designed and engineered for the job it has to do. Conforming to A.W.W.A. standards in every detail, these KENNEDY valves offer many extra-value features . . . one being the iron itself, which is 50% stronger than ordinary cast-iron . . . to keep them on the job year in and year out.

KENNEDY manufactures a most complete line of water works valves . . . in sizes from 2" to 60" . . . non-rising stem and outside-screw-and-yoke types . . . with a wide variety of gearing arrangements, controls, accessories and end connections available.

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VALVES • PIPE FITTINGS • FIRE HYDRANTS

## *The Reading Meter*

(Continued from page 82)

**Water Resources of the Lake Erie Shore Region in Pennsylvania.** *John W. Mangan, Donald W. Van Tuyl, & Walter F. White Jr. Circular 174, Geological Survey, Washington, 25, D.C. (1952) 36 pp.; paperbound; free*

Abundant and inexhaustible supplies—with Lake Erie as their source—characterize this region of Pennsylvania. Ground water is little used, although available for development.

**How to Get Sewage Treatment Works in Ohio.** *Ohio Dept. of Health and Ohio River Valley Water Sanitation Com., 414 Walnut St., Cincinnati 2, Ohio (1952) 40 pp.; paperbound; \$1*

Billed as "a guide describing recommended step-by-step engineering and financial procedures," this booklet should be helpful to the "councilmen, mayors and city managers, . . . engineers and public spirited citizens" for whom it was intended, and not only in Ohio, but elsewhere. Intended for the layman, the study includes careful definitions of technical terms; for the politician, a careful chart of administrative, legal, and fiscal details; for the skeptic, matter-of-fact summaries of the action already taken by several cities.

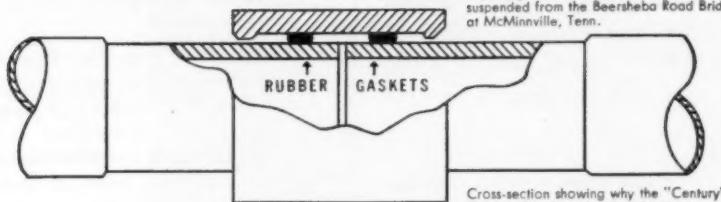
**A new plastic material** has been developed by Atlas Mineral Products Co. of Mertztown, Pa., and, after trial marketing in Philadelphia for the past year, will now be distributed internationally. Known as Ampcoflex, the rigid plastic is available as extruded pipe with molded fittings, formed containers, and fabricated tanks.



**A new type** of ratchet pipe wrench has been developed by Lurie & Lurie, 126 N. Union Ave., Chicago 6, Ill. At present available only in the 18-in. size, the novel design, according to the makers, offers the advantages of ready application to pipe in relatively inaccessible locations, ratchet action, and the exertion of powerful gripping force through toggle type construction of the handle.



"Century" Asbestos-Cement Pressure Pipe suspended from the Beersheba Road Bridge at McMinnville, Tenn.



Cross-section showing why the "Century" Simplex Coupling absorbs vibrations.

## Cross your bridges with . . . "CENTURY"

### asbestos-cement pressure pipe

Built for crossing bridges when it comes to them, "Century" Asbestos-Cement Pressure Pipe withstands vibration due to its inherently rugged construction and the rubber cushioning of its "Century" Simplex Couplings.

As you can see from the cross-section of the "Century" Simplex Coupling above, the pipe ends float in rubber gaskets which absorb these vibrations and the separation of pipe ends within the coupling localizes them to the individual pipe sections. Each coupling serves as an expansion joint.

Its light weight and handy lengths are easy to attach to bridge structures. Economies result because specially skilled labor is not

required. It can be cut on the job, and "Century" Simplex Couplings safely allow up to 5° of deflection for each pipe length. Over the years its strength actually increases, and its smooth inner surface assures continuous maximum carrying capacity. The usual painting expense is completely eliminated. Here is high performance at low cost in water mains. Write for full data.

*Write for Free Booklet, "Mains without Maintenance." Contains valuable reference material, specifications, and data for anyone interested in pipe for water mains.*

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~ 1946 ~

286 Pages

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Both cash and credit orders from AWWA members will receive promptest attention if sent directly to the APHA office. If credit is desired, please indicate your AWWA affiliation on the order.

•

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ASSOCIATION**



## Service Lines

Liquid level control of a new, electrical type is described in a 4-page bulletin, GEA-5766, which may be obtained from General Electric Co., Schenectady 5, N.Y. Known as Thermasul, the control unit consists of a heated, temperature-sensitive resistor through which a current flows to a relay. When immersed in water, the increased heat conduction lowers the temperature, with a resultant increase in current sufficient to operate the relay.

Clarification with the Rex Verti-Flo Clarifier is the subject of a 12-page bulletin distributed by Chain Belt Co., Box 2022, Milwaukee 1, Wis. The unit utilizes a combination of baffled compartments, upward flow, adjustable effluent weirs, and conveyer collection chains.

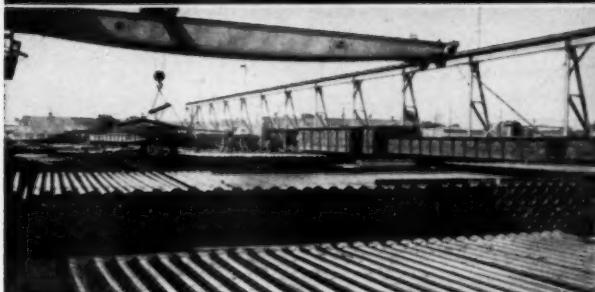
Mechanical draft cooling towers are discussed in an 8-page booklet issued by the Water Cooling Div., Binks Mfg. Co., 3122 Carroll Ave., Chicago 12, Ill. Illustrations, tables of dimensions and capacities, and specifications tell the story.

Dump truck hoists and bodies are the subject of an 8-page booklet available from the Customer Service Dept. of St. Paul Hydraulic Hoist, Wayne, Mich.

Allspeed Motor Drives—upright and horizontal, closed and skeleton type—are depicted in a 16-page bulletin offered by Worthington Corp., Harrison, N.J. Requests should be made on business stationery.

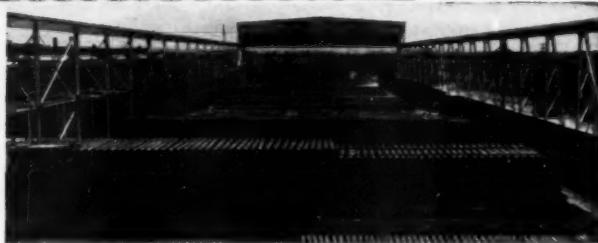
*(Continued on page 88)*

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Pipe Foundry Shipping Yards at McWane Cast Iron Pipe Co., Birmingham, Ala.

Shipping Yards  
Pacific States  
Cast Iron Pipe  
Co., Provo, Utah.



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Prompt, quick shipment by rail or truck now is available from our stock yards of McWane-Pacific DeLavaud Centrifugal Cast Iron Pipe in sizes 4" and larger, 18' lengths.

Furnished either tar coated or cement lined and you may have your choice of open-bell Bell-and-Spigel, precalked Bell-and-Spigel, or Mechanical Joint. The Federal Government has recently placed Cast Iron pressure pipe and fittings under building materials category and your former 45-day limitation on pipe inventory has been changed to allow inventory based on practical working requirements. For quick shipment, telegraph or telephone our nearest Sales Office.

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Dallas, Texas. ....	1501 Mercantile Bk. Bldg.

### PACIFIC STATES Cast Iron Pipe Co. Provo, Utah

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Portland 4, Oreg. ....	501 Portland Trust Bldg.
Salt Lake City. ....	Waterworks Equip't Co.

(Continued from page 22)

Within a 250-mile radius	571
250-500 miles	525
500-750 miles	161
750-1,000 miles	269
1,000-1,500 miles	423

My calculations indicate that man-miles of travel to and from the Kansas City meeting totaled approximately 3,000,000. If we were to calculate cost at an average of 4¢ per mile, the cost of transportation to and from the Kansas City meeting would total approximately \$120,000. Although this is a lot of money, such expenditures are certainly justified by the wealth of information made available to those attending the meeting.

In your summation, five states were shown to have no representation at the Kansas City meeting. These were Idaho, Nevada, New Hampshire, New Mexico, and Wyoming. Perhaps something can be done to secure adequate representation from these states at the Grand Rapids meeting next year.

E. A. SIGWORTH

Chm., AWWA Transportation Com.  
Chemist, Indus. Chemical Sales Div.  
West Virginia Pulp & Paper Co.  
New York, N.Y.; July 29, 1952

Heil Sig.—Ed.

(Continued from page 86)

**Liquid level gages**, instrument valves, and other specialties are cataloged in a folder distributed by Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

**A solids-level** bin indicator is described in a folder on the Bin-Vue obtainable from Convair, Pittsburgh, Pa. The indicator is said to be applicable to any dry bulk material that flows, whatever its texture or weight. The unit is based on a mechanical reaction to the dry material, and is powered by a 1/200-hp motor.

**A small pump** reference chart offers a guide to the displacement pump line of Tuthill Pump Co., 939 E. 95th St., Chicago 19, Ill.

**The Syntron line** of vibratory feeders and other production and maintenance aids is described in a catalog folder entitled "30 Ways You Can Save." Copies may be requested from Syntron Co., Homer City, Pa.

**Sheaves** for motor drives are discussed in a folder issued by Allis-Chalmers Mfg. Co., Milwaukee 1, Wis. Known as the Vari-Pitch Sheaves with Magic-Grip Bushings, their design permits letting the belt ride either higher or lower in the sheave, thus effectively changing its diameter and altering the speed.

**BOND-O**  
*Homogenized*

Machine blended for  
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Whether you buy one or a thousand

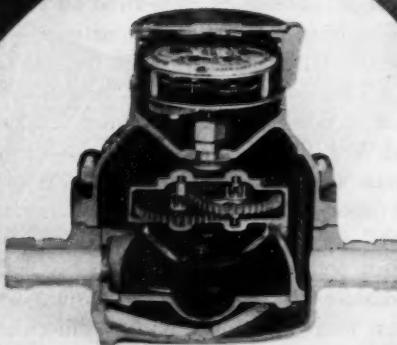
# HERSEY WATER METERS

you will find them uniformly accurate and dependable

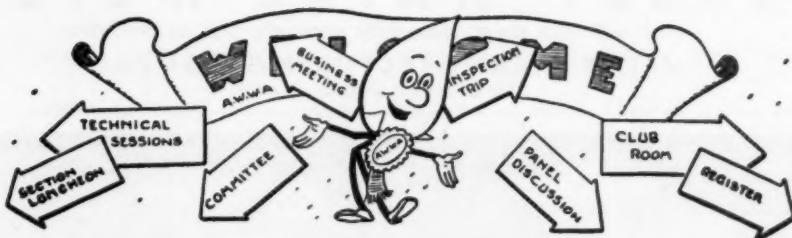
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## Section Meeting Reports

**Canadian Section:** The 32nd annual convention of the Canadian Section, held at the Mount Royal Hotel, Montreal, on May 26th-28, brought out a registration of 756, the second highest on record. The attractions of the city of Montreal and the interesting program were responsible for this high registration. Members came from all parts of Canada and there were many guests from the U.S. The national Association was represented by Secretary H. E. Jordan, while past-presidents of the Association included Linn H. Enslow, New York and Wendell R. LaDue, Akron, Ohio. President E. M. Jones of the Water & Sewage Works Manufacturers Assn. and W. J. Orchard of Newark also attended.

The program was divided between written papers and guided discussions. One paper dealing with the "Experiences of a Woman Water Works Operator," was presented by Mrs. Lucy T. Whyman of Tolleson, Ariz. (see August JOURNAL, p. 655). Fluoridation of public water supplies received considerable attention, a symposium of four papers discussing this subject from four different angles. "Fluoridation and the Dentist" was the topic of F. A. Kohli, director of dental services, Ontario Dept. of Health, who reviewed the very encouraging results that have been obtained

(Continued on page 92)

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### Manual of British Water Supply Practice

*Compiled by the Institution of Water Engineers, London*

The essence of the water supply art, as practiced in Great Britain, is well documented in this 900-page compilation. Generously supplied with illustrations and reference lists.

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 is no stronger  
 than its joints.*

**POWDER OR PIGS—WITH FIBREX  
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*Working Samples on Request.*

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(POWDER)



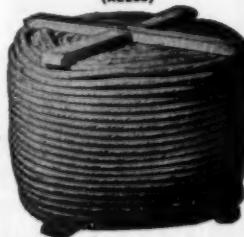
**HYDRO-TITE**

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**HYDRAULIC DEVELOPMENT CORPORATION**

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(Continued from page 90)

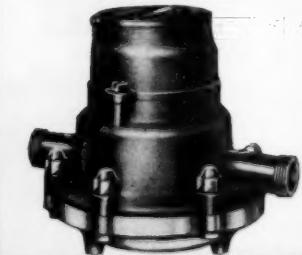
at Brantford, Ont., and places in the U.S. Adelard Groulx, director of the Montreal, Que., Dept. of Health, showed that health officers were interested in this project, and that there was no indication that it had any injurious effect on the system. A. E. Berry, director of the San. Eng. Div. of the Ontario Dept. of Health, pointed out that it was the responsibility of the water works operator to carry out the application of fluoride compounds to water after the decision had been reached by the medical and dental groups. D. B. Williams, in charge of water purification at Brantford, Ont., discussed the methods for applying fluoride to water, and reviewed the experiences of his city.

In a paper on the "Construction and Operation of a Booster Pumping Station," R. L. Dobbin, general manager of the Peterborough Utilities Com., outlined in detail the problems encountered in designing and constructing a small station. The final paper on the program, prepared by Robert F. Legget and C. B. Crawford of the Div. of Building Research of the National Research Council at Ottawa, was a research study on "Soil Temperature in Water Works Practice," which is tentatively scheduled for publication in the October JOURNAL.

(Continued on page 94)

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**INTERCHANGEABILITY**  
*Cuts Costs*

Individual parts as well as entire assemblies of Buffalo AMERICAN Water Meters can be interchanged. Repairs are made quickly at low cost. Stocks held at a minimum. Write for details.



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**Stop Joint Leakage**

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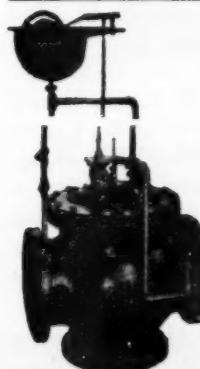
Controls elevation of water in tanks, basins and reservoirs

1. Single Acting
2. Double Acting



REDUCING VALVE

Maintains desired discharge pressure regardless of change in rate of flow



FLOAT VALVE

Maintains levels in tank, reservoir or basin

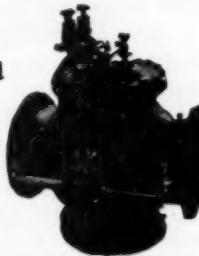
1. As direct acting
2. Pilot operated and with float traveling between two stops, for upper and lower limit of water elevation.

Maintains safe operating pressures for conduits, distribution and pump discharge



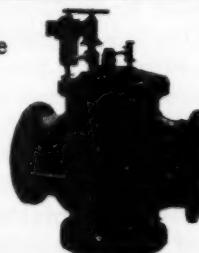
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Combination automatic control both directions through the valve.



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**ROSS VALVE MFG. CO., INC., P. O. BOX 593, TROY, N. Y.**

(Continued from page 92)

One of the guided discussions dealt with the "Hydrant Thread Standardization Program." With W. E. MacDonald, water works commissioner of Ottawa, Ont., as chairman, there followed a keen discussion on the need for standardization of hydrant outlets. As a result of the committee's report and the discussion which followed, a resolution was passed by the meeting recommending that standardization be on a continent-wide basis, and that the hydrant outlets should be standardized at  $7\frac{1}{2}$  threads per inch, in contrast to the standard adopted by the Canadian Standards Assn. of 5 to the inch. The section unanimously adopted this recommendation so that the standard would be the same as that used in the U.S. A subcommittee was empowered to deal with this matter further, and to take steps to implement the recommendation.

The only other guided discussion which time permitted dealt with the problem of supplying water to outside areas. The procedure varies a great deal across the country, and numerous problems are encountered.

One of the important features of the convention was an inspection trip to the Beauharnois Power Development in the province of Quebec. This trip involved most of the day, and the members were the guests of the Quebec Hydro-Electric Com. There they were able to see at first hand the great power development works under construction.

The hospitality of the city of Montreal was thoroughly demonstrated by many events. One of the highlights of the convention was a reception and cocktail party by Mayor Camillien Houde held at the Chalet on Mount Royal.

At the annual banquet, awards and certificates were presented to a number of members, including the Past-Chairman's Certificate to Ronald Harrison; an engraved cane to the outgoing chairman, T. J. Lafreniere; the Hunt Memorial Award for efficiency in water works operation to Allan Kilpatrick, Montreal; AWWA Life Membership Certificates to 20; as well as Membership Service Certificates for those who have held continuous membership of 15 years or longer. Recognition was paid to W. E. MacDonald of Ottawa for the Fuller Memorial Award, which he received at the Kansas City Convention; and to Norman J. Howard for the Honorary Membership in the Association, which he received at the same convention. A pleasing feature at the banquet was the recognition of R. J. Smith of Perth and R. H. Martindale of Sudbury for over 50 years of continuous service in the water works field in their municipalities. Each received an engraved silver tray.

The newly elected chairman of the Section is W. D. Hurst, city engineer of Winnipeg, who has also been elected to serve for a period of three years as Director of the Section on the AWWA Board.

A. E. BERRY  
*Secretary-Treasurer*



**It Pays to Buy HAYS . . . high quality water service bronze, 85-5-5-5 mix . . . hydrostatically tested at 200 lbs. or more . . . plugs individually ground in for perfect fit . . . Hays Corporation Stops can be inserted with your tapping machine.**



COPPER + BRASS + LEAD + IRON  
**WATER WORKS PRODUCTS**  
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## Coming Meetings

### AWWA SECTIONS

**September 15-17**—Kentucky-Tennessee Section at Andrew Johnson Hotel, Knoxville. Secretary, R. P. Farrell, Director, Div. of San. Eng., Tenn. Dept. of Pub. Health, 420 6th Ave., N., Nashville 3, Tenn.

**September 16-17**—Rocky Mountain Section at Frontier Hotel, Cheyenne. Secretary, George J. Turre, San. Engr., Board of Water Comrs., Box 600, Denver, Colo.

**September 16-18**—Wisconsin Section at Hotel Loraine, Madison. Secretary, Leon A. Smith, Supt., Water & Sewerage, City Hall, Madison 3, Wis.

**September 18-19**—Ohio Section at Netherland Plaza Hotel, Cincinnati. Secretary, M. E. Druley, Dist. Mgr., Dayton Power & Light Co., Wilmington, Ohio.

**September 21-23**—Missouri Section at Hotel Governor, Jefferson City. Secretary, Warren A. Kramer, Div. of Health, State Office Bldg., Jefferson City, Mo.

**September 24-26**—Michigan Section at Post Tavern, Battle Creek. Secretary, T. L. Vander Velde, Chief, Section of Water Supply, State Dept. of Health, Lansing, Mich.

**October 2-3**—West Virginia Section at Chancellor Hotel, Parkersburg. Secretary, Harry K. Gidley, Director, Div. of San. Eng., State Dept. of Health, Charleston 5, W.Va.

**October 12-15**—Southwest Section at Mayo Hotel, Tulsa. Secretary, Leslie A. Jackson, Mgr.-Engr., Munic. Water Works, Robinson Memorial Auditorium, Little Rock, Ark.

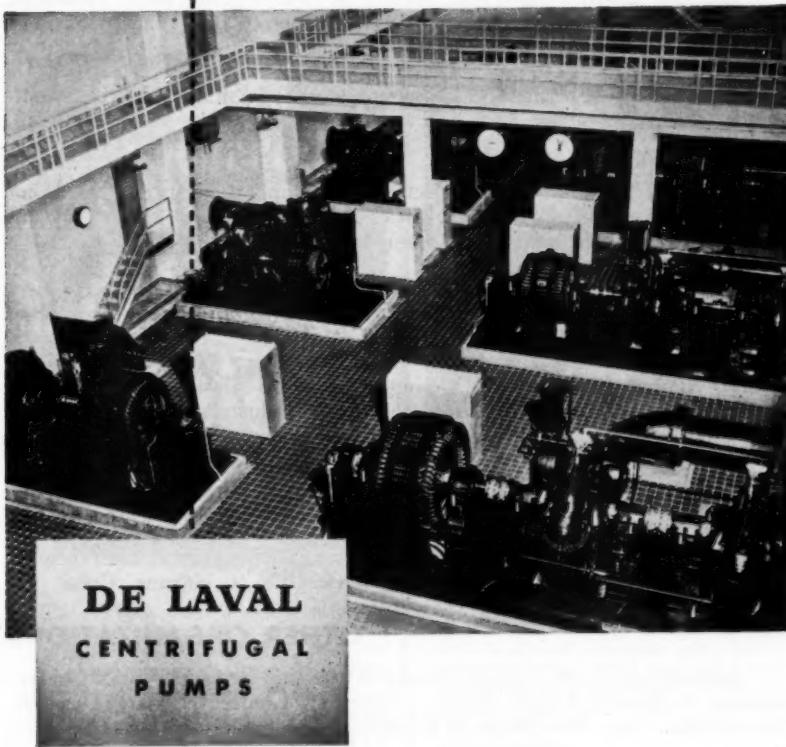
**October 21-22**—Maritime Branch, Canadian Section, at Lord Beaverbrook Hotel, Fredericton, N.B. Secretary, J. D. Kline, Chief Engr., Public Service Com., Box 574, Halifax, N.S.

**October 23-25**—New Jersey Section at Madison Hotel, Atlantic City. Secretary, C. B. Tygert, Wallace & Tiernan Co., Inc., Box 178, Newark 1, N.J.

**October 23-25**—Iowa Section at Hotel Hanford, Mason City. Secretary, H. V. Pedersen, Supt. of Water Works, Municipal Bldg., Marshalltown, Iowa.

*(Continued on page 98)*

## *Delivering 172 mgd more for Cleveland*



These new De Laval centrifugal pumps in the Nottingham filtration plant help deliver an additional 172,000,000 gallons of filtered water daily to Cleveland's growing population. Today 80% of America's larg-

est cities depend upon efficient De Laval centrifugal pumps. They are available in capacities ranging from less than one million gallons per day to more than 100 million gallons per day.



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## *Coming Meetings (contd.)—AWWA SECTIONS*

**October 28-31**—California Section at Huntington Hotel, Pasadena. Secretary, John C. Luthin, Mgr. & Engr., Monterey Bay Water Co., 1113 Laurent St., Santa Cruz, Calif.

**October 29-31**—Chesapeake Section at Wardman Park Hotel, Washington, D.C. Secretary, Carl J. Lauter, 6955 33rd St., Washington 15, D.C.

**November 5-7**—Virginia Section at Chamberlin Hotel, Old Point Comfort. Secretary, W. H. Shewbridge, Regional Engr., State Dept. of Health, 708 State Office Bldg., Richmond, Va.

**November 10-12**—North Carolina Section at Skyland Hotel, Hendersonville. Secretary, E. C. Hubbard, Exec. Secy., State Stream Sanitation Com., Box 2091, Raleigh, N.C.

**November 16-19**—Joint meeting of Alabama-Mississippi and Florida Sections of AWWA and Florida Sewage & Industrial Waste Assn., at San Carlos Hotel, Pensacola. Secretary, Alabama-Mississippi Section, Chas. W. White, Asst. San. Engr., State Dept. of Public Health, 537 Dexter Ave., Montgomery 4, Ala. Secretary, Florida Section, Marvin R. Boyce, Boyce Co., 504 Pennsylvania Ave., Clearwater, Fla.

**December 4-6**—Cuban Section in Havana. Secretary, Laurence H. Daniel, Pres., Laurence H. Daniel, Inc., Baratillo 9, Havana, Cuba.

## OTHER ORGANIZATIONS

**September 17-19**—South Dakota Water and Sewage Works Conference at St. Charles Hotel, Pierre. Secretary, Charles E. Carl, Director, Div. of San. Eng., State Dept. of Health, Pierre, S.D.

**September 24-26**—Georgia Water & Sewage Operators' School at Georgia Inst. of Technology, Atlanta. Details from N. M. deJarnette, Assoc. Director, Water Pollution Control, State Dept. of Public Health, Atlanta, Ga.

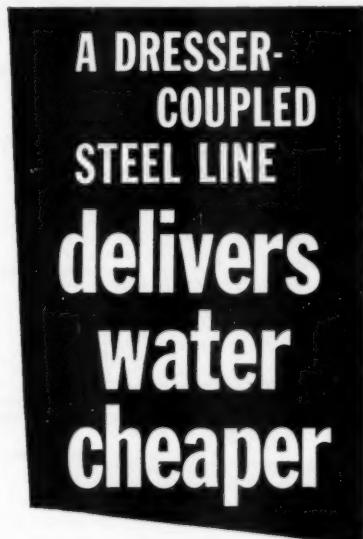
**September 3-October 3**—California Municipal Utilities Assn. at U. S. Grant Hotel, San Diego. Secretary, F. V. Frey, Supervisor, Light & Power Dept., Pasadena.

**October 6-9**—Federation of Sewage & Industrial Wastes Assns. Silver Anniversary Meeting at Hotel Statler, New York, N.Y. Reservations being handled directly by the hotel.

**October 20-24**—American Public Health Assn. Annual Conference at the Public Auditorium, Cleveland, Ohio. Details from Reginald M. Atwater, Exec. Secy., APHA, 1790 Broadway, New York, N.Y.

**November 16-19**—Florida Sewage & Industrial Wastes Assn. (Joint meeting; see AWWA Alabama-Mississippi and Florida Sections.)

**Hyattsville, Md., Reports:** Thomas G. Vivadelli, of Nance & Vivadelli Co., says: "The use of Dresser Couplings in the installation of this 42" steel water main for the Washington Suburban Sanitary Commission, was a great help in cutting our installation costs. Not only do they save labor costs, but they also make a tighter line. We would highly recommend the use of Dresser Couplings on any project of this nature."



The cheapest way to deliver water to the place where it turns into revenue is with a Dresser-Coupled steel line—the line that cuts installation costs, leakage losses and maintenance costs.

Speed in getting water to a new housing or defense project is usually of great importance. Both to the construction schedule of the project and to your own installation costs. And, with a Dresser-Coupled steel line, you save time two ways. First, the long, strong



sections of steel pipe mean fewer joints per mile. Second, those joints are more quickly made with Dresser Couplings because these factory-made joints are easy for any workmen to install—even in wet weather.

Leakage losses are cut because with Dressers you get controlled gasket pressure, provided by controlled bolt tightness around the joint. Also because these gaskets harmlessly absorb stresses of vibration, contraction and expansion.

Maintenance costs are reduced by permanent joint tightness. Furthermore, with Dressers there is no heat in joint-making to damage the glass-smooth pipe lining. High carrying capacity is sustained.

From all standpoints, a Dresser-Coupled steel line gives you the ultimate in performance and economy. See your Dresser Sales Engineer or write our Bradford Office for literature.

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Dresser Manufacturing Division, 59 Fisher Ave., Bradford, Pa. (One of the Dresser Industries). Warehouses: 1121 Rothwell St., Houston, Texas; 101 S. Bayshore Highway, South San Francisco, California. Sales Offices: New York, Philadelphia, Chicago, Houston, South San Francisco. In Canada: 629 Adelaide St., West, Toronto, Ontario.

**Be sure** you get the best line at the best price. Put steel pipe and Dresser Couplings in your specifications.

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Industrial Chemical Sales Div.  
Permutit Co.

## Aerators (Air Diffusers):

American Well Works

Infico Inc.

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Worthington Pump & Mach. Corp.

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General Chemical Div.

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Wallace & Tiernan Co., Inc.

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## Chemists and Engineers:

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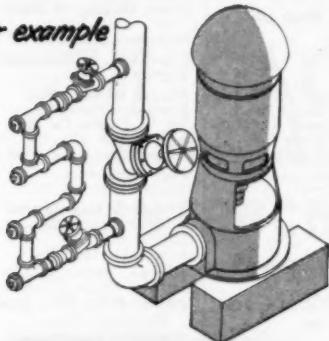
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# How's This For Solving a Valve Problem

...on Corrosive Well Water,

for example



## THE INSTALLATION

On outlet of well water pump supplying plant of Barr Rubber Products Co., Sandusky, Ohio. Sulphur content of water extremely high.

## THE HISTORY

Valves formerly used here lasted no more than 6 months. Under constant exposure to severe erosive and corrosive effects, they failed to provide the easy operation and positive seating needed in this service. They required excessively frequent re-packing and seating maintenance.

Problem solved by replacing with Crane Packless Iron Body Diaphragm valves in main line and by-pass. Installed more than a year, they show no corrosion, no effects of service. Operate smoothly, seat tightly, with no maintenance needed to date.

VALVE SERVICE RATINGS	
SUITABILITY:	Just what was needed
MAINTENANCE COST:	None to date
CORROSION-RESISTANCE:	No evidence of corrosion
SERVICE LIFE:	Outlasted any 2 other valves at far
OPERATING RESULTS:	Pump shutdowns for valve repairs stopped
PRICE:	Much less than alloy valves
AVAILABILITY:	Stock item in Crane line

## THE VALVE

Crane No. 1611 Iron Body Packless Diaphragm Valves featuring separate disc and diaphragm. No packing to maintain; no stem leaks. Neoprene diaphragm used to seal bonnet only. Independent disc with neoprene insert insures positive seating even should diaphragm fail. Also fully neoprene lined valves. Many common and corrosive services. See your Crane Catalog or Crane Representative.

The Complete Crane Line Meets All Valve Needs. That's Why,  
More Crane Valves Are Used Than Any Other Make!

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### FEATURES

- High accuracy
- Extremely wide feeding range
- Simple, rugged construction
- Handles any dry material
- Has large dissolving chamber of retention type

- Dustproof in operation
- Equipped with hydraulic jet agitator or high speed, motor driven mechanical mixer
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For complete information and Bulletin 20-G14, address Omega Machine Company (Division of Builders Iron Foundry), 365 Harris Ave., Providence 1, Rhode Island.



**OMEGA**  
The Last Word in Feeders



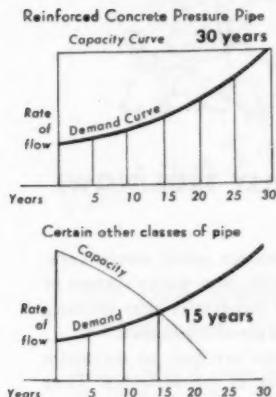
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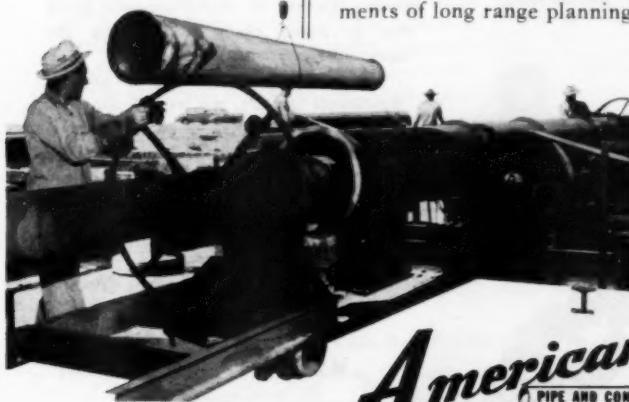
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